COMPARISON OF TIME SLICE WINDOWS ANALYSIS WITH THE DELAY ANALYSIS METHODS FREQUENTLY USED IN THE CONSTRUCTION INDUSTRY: A CASE STUDY

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submitted by **TOLGAHAN ÖZKAN** in partial fulfillment of the requirements for the degree of **Master of Science in Civil Engineering, Middle East Technical University** by,

Prof. Dr. Naci Emre Altun
Dean, **Graduate School of Natural and Applied Sciences** ________________

Prof. Dr. Erdem Canbay
Head of the Department, **Civil Engineering** ________________

Prof. Dr. Mustafa Talat Birgönül
Supervisor, **Civil Engineering, METU** ________________

Prof. Dr. İrem Dikmen Toker
Co-Supervisor, **Construction Management and Eng., University of Reading** ________________

Examining Committee Members:

Prof. Dr. Rıfat Sönmez
Civl Engineering, METU ________________

Prof. Dr. Mustafa Talat Birgönül
Civil Engineering, METU ________________

Assoc. Prof. Dr. Güzide Atasoy Özcan
Civil Engineering, METU ________________

Assoc. Prof. Dr. Hande Işık Öztürk
Civil Engineering, METU ________________

Assoc. Prof. Dr. Emre Caner Akçay
Civil Engineering, Atılım University ________________

Date: 24.04.2024

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name Last name : Tolgahan Özkan

Signature :

ABSTRACT

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Özkan, Tolgahan
Master of Science, Civil Engineering
Supervisor : Prof. Dr. Mustafa Talat Birgönül
Co-Supervisor: Prof. Dr. İrem Dikmen Toker

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Delays are inevitable in construction projects, and they mostly result in disputes between contractor and employer because they impact the project completion date, which could lead to extension of time and monetary compensation claims or exposure to liquidated damages. Therefore, proper analysis of delays is crucial to determining the causes of critical delays and the responsible party. Multiple delay analysis methods are used in the construction industry to determine the causes of critical delays in order to calculate the extension of time and monetary compensation or liquidated damages accurately. However, each of these methods has strengths and weaknesses. The Society of Construction Law (SCL) analyzed a delay scenario using commonly used delay analysis methods in the Great Delay Analysis Debate. In this thesis, the same delay scenario was analyzed using the time slice windows analysis method. The results of the time slice windows analysis were compared with the results of other delay analysis methods, namely impacted as-planned, as-planned vs. as-built, collapsed as-built, and time impact analysis. The strengths and weaknesses of each delay analysis method were determined. The findings show that time slice windows analysis can identify important issues that are not easily identified by other methods, such as concurrent delays, accelerations, or changes in critical path throughout the course of the project. This research also concluded that the time slice windows analysis method is not only a delay analysis method, but also a key method for improved project and contract management during the execution of a project. However, time slice window analysis is also difficult and time-consuming to perform, and it requires as-planned and updated programs or physical progress data along with extensive as-built record-keeping.

Keywords: Construction Management, Delay Analysis Methods, Extension of Time, Construction Claims, Construction Delays

ÖZ

ZAMAN DİLİMİ PENCERE ANALİZİNİN İNŞAAT SEKTÖRÜNDE SIKÇA KULLANILAN GECİKME ANALİZİ METODLARI İLE KARŞILATIRMASI: VAKA ANALİZİ

Özkan, Tolgahan
Yüksek Lisans, İnşaat Mühendisliği
Tez Yöneticisi: Prof. Dr. Mustafa Talat Birgönül
Ortak Tez Yöneticisi: Prof. Dr. İrem Dikmen Toker

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İnşaat projelerinde gecikmelerin yaşanması sıkça karşılaşılan bir olay olup, projenin tamamlanma tarihini etkilemesi nedeniyle yüklenici ve işveren arasında anlaşmazlıklara yol açmakta, bu da süre uzatımına, parasal hak taleplerine veya gecikme cezasına maruz kalınmasına yol açabilmektedir. Bu nedenle gecikmelerin doğru analizi, kritik gecikmelerin nedenlerinin ve sorumlu tarafın belirlenmesi açısından önem taşımaktadır. İnşaat sektöründe süre uzatımı ve parasal hak talepleri veya gecikme cezalarının doğru bir şekilde hesaplanması amacıyla kritik gecikmelerin nedenlerinin belirlenmesi amacıyla gecikme analizi yöntemleri kullanılmaktadır. Ancak bu yöntemlerin her birinin güçlü ve zayıf yönleri vardır. İnşaat Hukuku Derneği'nin (SCL), Great Delay Analysis Debate isimli yayınında sıklıkla kullanılan gecikme analizi yöntemleri kullanılarak bir gecikme senaryosu analiz edilmiştir. Bu tezde aynı gecikme senaryosu, zaman dilimi pencereleri analiz yöntemi kullanılarak analiz edilmiştir. Zaman dilimi pencereleri analizinin sonuçları, diğer gecikme analizi yöntemlerinin (planlanan üzerinden etkilenen, planlanan vs. gerçekleşen, gerçekleşenden çıkarılan ve zaman etkisi analizi) sonuçlarıyla kıyaslanmıştır ve her bir gecikme analizi yönteminin güçlü ve zayıf yönleri belirlenmiştir. Bulgular, zaman dilimi pencereleri analizinin, proje boyunca eşzamanlı gecikmeler, hızlanmalar veya kritik yoldaki değişiklikler gibi diğer yöntemlerle kolayca tespit edilemeyen önemli sorunları tespit edebildiğini göstermektedir. Bu araştırmada aynı zamanda zaman dilimi pencereleri analiz yönteminin yalnızca bir gecikme analizi yöntemi olmadığı, ve bir projenin yürütülmesi sırasında daha iyi bir proje ve sözleşme yönetimi için önemli bir yöntem olduğu sonucuna varılmıştır. Bununla birlikte, zaman dilimi pencere analizinin uygulanması zor ve zaman alıcı olması nedeniyle, güncellenmiş iş programları veya ilerleme verilerinin yanı sıra proje kayıtlarının kapsamlı olarak tutulmasını gerektirmektedir.

Anahtar Kelimeler: İnşaat Yönetimi, Gecikme Analizi Yöntemleri, Süre Uzatımı, İnşaat Hak Talepleri, İnşaat Gecikmeleri

To My Beloved Family

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ABBREVIATIONS	
APvsAB	As-Planned vs. As-Built
CAB	Collapsed As-Built
CD	Compensable Delay
CP	Critical Path
CPM	Critical Path Method
DAMUDS	Delay Analysis Method Using Delay Section
EBFM	Enhanced But-For Method
EDWDA	Enhanced Daily Windows Delay Analysis
EOT	Extension of Time
ED	Excusable Delay
IAP	Impacted As-Planned
ICBP	Isolated Collapsed But-For
LD	Liquidated Damage
MBF	Modified But-For
MSvsMUS	Modified Schedule versus Modified Updated Schedule
MTIA	Modified Time Impact Analysis
NED	Non-Excusable Delay
SCL	Society of Construction Law
TIA	Time Impact Analysis
TSWA	Time Slice Windows Analysis

CHAPTER 1

INTRODUCTION

The majority of construction projects experience delays that lead to requests for an extension of time (EOT) or exposure of liquidated damages. This determination is based on the contractual terms governing the responsibilities of either the contractor or the employer (Shabbar et al., 2017). On average, it has been reported that 70% of projects experience delays which result in extensions to the project timeline ranging from 10% to 30% (Assaf & Al-Hejji, 2006). Once a delay has occurred, it may result in liquidated damages to the contractor, an extension to contractual completion date, or monetary compensation to the contractor (Hanna et al., 2016).

Parties to construction contracts frequently employ various delay analysis methods to determine their entitlement to extension of time, or liquidated and ascertained damages (Bektas et al., 2020). A number of methodologies have been developed to assess delays and their impacts, but courts and administrative boards have not specified any standard method for evaluating delay impacts (Arditi & Pattanakitchamroon, 2008). The selection of the proper analysis method depends upon a variety of factors, including the information available, the time of analysis, the capabilities of the methodology as well as time allocation, funds, and effort allocated to the analysis. The results of delay analysis may be influenced by the method selected and therefore the selection of the most appropriate method is important to all parties concerned (Arditi & Pattanakitchamroon, 2006).

The five most frequently used methodologies for delay analysis are: (1) the as-planned versus as-built method, (2) the impacted as-planned method, (3) the collapsed as-built method, (4) the time impact analysis method, and (5) the time slice windows analysis method (Nguyen & Ibbs, 2008). Some methods start by identifying the cause of a delay and then calculating its effects. Other methods start by identifying the effect of delays on a contractual milestone and then try to determine what might have caused the delay (SCL, 2017). Hence, even the selection of delay causes differs from one method to another. Birgonul et al. (2014) have identified the common shortcomings of delay analysis methods. These shortcomings include recognizing the critical path changes, concurrent delays, accelerations, mitigations, float consumption, effect of non-working days, activity sequence changes, variation orders, and so on.

Researchers have performed multiple delay analyses methods on delay scenarios to compare the results (Bubshait & Cunningham, 1998; Farrow, 2007; Kao & Yang, 2009; Al-Gahtani & Mohan, 2011). However, delay scenario used in their research was simple and had pre-determined delay events. Hence, the delay scenarios did not include complicated situations that might reveal the strengths or weaknesses of the methods regarding common shortcomings in terms of critical path changes, concurrent delays, accelerations, and variation orders. Furthermore, due to the differing definitions of pre-determined delay events used, the delay event identification process used in these methods was not compared.

SCL (2006) published the Great Delay Analysis debate where a delay scenario was analyzed by using four of the frequently used delay analysis methods, which were impacted as-planned, as-planned vs. as-built, collapsed as-built, and time impact analysis. The delay scenario contained an as-planned schedule, an as-built schedule, a contract document, and as-built documentation such as daily progress records where delay events were identified by each analyst who performed an analysis by using one of the four methods based on the characteristic of the method. Furthermore, the delay scenario was complicated enough to contain situations such as critical path changes, concurrent delays, accelerations, variation orders, effect of non-working days, float consumptions, multiple float paths, and activity sequence changes. A detailed comparison could have been made between the results of each analysis method, stating the strengths and weaknesses of each method, yet only a brief comparison of results of each analysis method was made in the published document by SCL (2006). Since the published document did not include the time slice windows analysis method and the delay scenario was complicated enough to make a detailed comparison of results so that the strengths and weaknesses of each method could be discussed, a time slice windows analysis is conducted in this thesis to analyze the delay scenario. The results of time slice windows analysis were then compared with the results of other methods to determine the strengths and weaknesses of each delay analysis method.

The main aim of this thesis is to identify the strengths and weaknesses of delay analysis methods by applying them in a case study of frequently used delay analysis methods to facilitate practitioners' selection of an analysis method based on the project records and requirements. The second aim is to provide practical guidance to practitioners concerning why and how delay analysis should be performed contemporaneously during project execution.

CHAPTER 2

LITERATURE REVIEW

2.1 Critical Path Method

The Critical Path Method (CPM) serves as a valuable project management instrument that aims to improve the planning, scheduling, and management of complex projects. CPM is applicable to a wide array of operational management fields, including but not limited to construction and manufacturing industries, agriculture, and academic research. CPM has become a widely adopted technique with enduring significance in diverse industries after originating in the late 1950s through the work of James E. Kelley and Morgan R. Walker. The main features of CPM are that it can be applied to address a category of "real-world" business challenges, the use of contemporary mathematical principles is essential to its application, its full implementation necessitates the use of substantial computing infrastructure, and it has achieved practical implementation (Kelley & Walkerf, 1959).

The main idea behind CPM is that the sequencing of interdependent tasks is what dictates the overall duration of the project. By systematically mapping out activities, dependencies, and durations, CPM provides project managers with a structured framework for optimizing workflows, resource allocation, and risk mitigation. Based on the studies of Galloway (2006), the major effective uses of Critical Path Method are pointed out below.

- Time-Related Project Tasks: Anticipates the project's completion date and establishes timeframes for individual activities, providing a basis for evaluating the impact of changes on project schedules and assessing time-related claims.

- Cost Management: Facilitates effective financial management by forecasting cash flows, minimizing exposure to liquidated damages, and calculating progress payments, contributing to the overall financial control of the project.
- Coordination and Communication: Enhances coordination efforts involving subcontractors and the assimilation of client-supplied information, promoting streamlined communication channels for improved project efficiency.
- Conflict Resolution: Serves as a valuable resource in addressing conflicts among different trades and mitigating supply-demand conflicts, thereby fostering a harmonious working environment that is conducive to successful project outcomes.
- Effective Project Control Tool: Acts as an essential instrument for overall project control, offering a comprehensive approach to managing time, costs, coordination, and conflict resolution for optimal project performance.

Although project managers aim to monitor the advancement of critical path activities, when it comes to complex schedules with multiple paths, project managers might seek a more detailed examination of the various paths within the schedule. Understanding the subsequent or closest longer path can be beneficial, as it has the potential to transform into the critical path if there are delays in activities. The capability to conduct multiple path analysis is especially advantageous for analyzing or monitoring schedules characterized by several float paths, all within a limited range of total float for activities. A report on multiple float paths provides an alert to the possibility of a non-critical path transforming into the critical path due to minor delays in activities. By presenting network paths in order of length or significance, a multiple float path report offers a more comprehensive analysis of the current schedule scenario, enhancing the understanding of potential criticality shifts.

2.2 Causes of Delays in Construction Projects

Delays in construction projects can occur due to various factors, and they often lead to increased costs and frustration among stakeholders. The main reasons behind the delay in construction projects have been pointed out in several studies (Sambasivan & Soon, 2007; Orangi et al., 2011; Kazaz et al., 2012; Haseeb et al., 2012; Sunjka & Jacob, 2013). Mbala et al. (2019) conducted a literature review and based on the above-mentioned research listed the following factors that cause delays in construction, which are sorted by their influence/occurrence rate in the construction industry:

- Inefficiencies in site management and the inherent complexities of construction projects
- A deficiency in skilled labor
- Poor project scheduling
- Alterations in design and the need for rework due to construction errors
- Incidents resulting from inadequate site safety practices
- Delays caused by subcontractors
- A deficiency and late delivery in on-site materials.
- Adverse weather conditions
- Fluctuations in prices in market conditions
- Delayed payment by the owner for performed work
- Ineffective communication and coordination between stakeholders

Delays in the construction industry can result in many construction companies facing time and cost overrun, contractual dispute and arbitration among project stakeholders, total or partial project abandonment, reputation damage, decreased productivity and morale, safety concerns, and regulatory compliance challenges (Aibinu & Jagboro, 2002; Tawfek & Bera, 2018). To mitigate these effects, effective project and contract management, risk assessment, and proactive problem-solving are crucial. Clear communication, proper planning, and the use of technology and best practices can help minimize the impact of delays in construction projects.

2.3 Effect of Delays

When a delay occurs, it can lead to liquidated damages being imposed on the contractor, an extension granted for the stipulated completion time, or monetary compensation provided to the contractor (Hanna et al., 2016).

Extension of Time (EOT) refers to the provision of additional time granted to the contractor as a form of compensation in instances where delays occur for reasons beyond their control, thereby preventing the imposition of unwarranted liquidated damages. EOT clauses are commonly used to compensate the contractor for lost time and allow for an extension of the project completion date without incurring liquidated damages from the employer. EOT allows for an adequate amount of time to finish the project, mitigates or prevents the imposition of liquidated damages, safeguards the owner’s ability to deduct such damages, and validates the claim for financial compensation in the event of project extension (El-adaway et al., 2016). The main benefit of an EOT to the Contractor is to relieve the liability of delay damages until the extended project completion date and to get compensated for the additional costs arising from extended project duration. Furthermore, it allows the contractor to prepare a revised baseline program where optimizations can be performed to save costs without being exposed to counter-claims from the employer related to concurrent delays. The benefit of an EOT for the employer is that it establishes a new contract completion date, prevents time for completion of the work becoming ‘at large,’ and allows for the coordination/planning of its own activities (SCL, 2017). However, EOT claims are not always settled in an amicable way due to the confrontational approaches adopted by both the contractor and employer (Shabbar et al., 2017).

Delay causes prolongation. Prolongation causes increased cost. Prolongation cost claims comprise time-related costs such as extended use of resources, financial costs, and overhead. Unless specified in the agreement, payment for extended time should only be made for the work completed, time expended, or actual losses incurred. Essentially, the calculation of costs caused by the prolongation of the project should only consider the additional expenses accrued by the Contractor. The objective is to put the Contractor in the same financial position it would have been had the delay not been caused by the employer. It is important to note that obtaining an EOT does not automatically entitle the Contractor to monetary compensation (SCL, 2017).

Schedule overruns result in financial losses to the employer. Calculating the actual damages incurred by the employer is perceived to be burdensome. Thus, most of the contracts include liquidated damages (LD) provisions that specify a predetermined rate based on the contract amount to be applied as a penalty in the event of a delay in the contractual completion date. LD can only be applied if non-excusable delays occur and the contractor fails to complete the project in accordance with the contractual milestones such as substantial completion, final completion, sectional completion, or intermediate milestones (Assaad & Abdul-Malak, 2020). LDs are a reflection of the additional expenses that an owner expects to incur due to the contractor's inability to finish the construction project within the agreed-upon timeframe. These damages are usually stipulated in the contract, specified as a predetermined rate, and enforced when the contractor exceeds the project deadline. The specified effective date and the corresponding amount or timetable of liquidated damages are meant to capture the financial repercussions for the owner that stem from the prolonged duration of the project, encompassing factors such as lost income, time-related administrative expenses, and supplementary financing charges (Levin, 2016).

2.4 Types of Delays According to Liability

Construction delays may be categorized into four groups: critical versus non-critical delays, excusable versus non-excusable delays, compensable versus non-compensable delays, and concurrent delays (Shabbar et al., 2017). Additionally, extension of time claims are assessed according to a combination of delay categories. Regarding the entitlement to EOT and prolongation costs, the combination of excusable and compensable delays can be categorized as compensable delays as it gives rise to entitlement to EOT and cost compensation, and excusable and non-compensable delays can be categorized as excusable delays as these give rise to entitlement to EOT without cost compensation (Mubarak, 2015).

Critical delays are those that affect a project's critical path and push a contractual milestone to a later date, whereas non-critical delays are those that do not affect a contractual milestone and only result in consumption of total float (Trauner, 2009).

In situations of compensable delay, the contractor typically has the right to receive an extension of the project deadline, resulting in adjustments to both the duration of the contract and the milestones for project completion. This may also involve an increase in the contract price to account for any additional expenses incurred as a direct result of the delay, such as increased overhead costs and other time-related expenses for the duration of the delay period (Levin, 2016).

Excusable delays refer to interruptions in the work program that are not directly attributable to either the employer or contractor. These delays are typically considered "Acts of God" or unanticipated events that are beyond the reasonable control of both parties. Force majeure clauses are usually included in construction contracts to elaborate the various causes of delay for which neither party is accountable. Although the terms depend on the contract language, delays caused by force majeure events generally give entitlement to an extension of time but not to prolongation costs (Yates & Epstein, 2006).

Non-excusable delays are delays that result from the direct actions or lack of action by the contractor, who should have anticipated the circumstances leading to the delay. In the event of a non-excusable delay, the contractor is not eligible for an extension of time or financial compensation, and may be subject to liquidated damages (Mubarak, 2015).

Finally, a concurrent delay is defined as the occurrence of multiple separate delay events happening simultaneously within the same period of time (Arif & Morad, 2013).

2.5 Delay Analysis Methodologies

The establishment of a cause-and-effect relationship of time-related disputes in construction projects is usually done through delay analysis techniques (Arditi & Pattanakitchamroon, 2006).

Delay analysis methods are categorized according to analysis type (cause and effect or effect and cause), the determination of critical path (prospective or contemporaneous or retrospective), and determination of delay impact (prospective or retrospective) by SCL (2017).

Some methods begin by identifying and describing an event (cause) and then aim to determine its effects (effect); these are cause and effect analyses. Other methods start by identifying the critical delay (impact) and then aim to determine what might have caused the delay; these are effect and cause analyses (SCL, 2017). The aim of delay analysis is to accurately establish a 'cause and effect' relationship of delays so that they can be attributed to the responsible party. Starting with the 'cause' requires the analyst to calculate the effect of that delay event. On the other hand, starting the analysis according to the actual delay suffered (the 'effect') requires the analyst to work backwards to determine the most likely 'cause' of that effect (Keane & Caletka, 2008).

Criticality can be determined in three distinct manners. One approach involves purely prospective critical path assessments, which focus solely on the perspective established at the beginning of the project without considering any work that has been completed. Another method is through contemporaneous critical path assessments, which analyze the project’s progress over time and consider how historical advancements and strategic changes may impact the predicted criticality. The third approach, retrospective critical path assessment, looks at the project from the perspective observed at the project’s completion or within a specific timeframe (SCL, 2017).

There are two primary methods for determining the impact of delays. One method involves a prospective delay analysis, which predicts the likely influence of past progress or delay incidents on a project’s completion date. The findings of a prospective delay analysis may not align with the as-built schedule due to the contractor’s potential adjustments in performance in response to factors such as attempted acceleration, resource re-sequencing, or redeployment efforts aimed at mitigating liabilities or unforeseen events. The second method, retrospective delay analysis, focuses on assessing the true effects of delay incidents on the critical path as identified in the actual or as-built schedule (SCL, 2017).

Additive delay analysis methods are typically carried out in prospectively, especially during the implementation of a project when the actual impact of a delay event remains unknown. During this phase, the potential effect on project completion is determined through estimation or forecasting, utilizing the most accurate information available at that time. These methodologies depend on either the original plan or the latest revised work schedule to pinpoint the critical path of the project. Additive delay analysis methods involve a theoretical computation based on the data accessible at the moment the event takes place. While the ‘cause’ of the delay has been identified, the ‘effect’ must be assessed by the analyst (Keane & Caletka, 2008).

2.5.1 As-Planned vs. As-Built

The most common method of delay analysis is performed by comparing the as-planned with the as-built program. This entails a comparison of the original intention of the program with the as-built program to enable an assessment of where delays occurred at any particular period of time (Farrow, 2007). The as-planned vs. as-built analysis relies on common sense to make a comparison of before-and-after delay events (Arditi & Pattanakitchamroon, 2006). It considers both the as-planned and as-built schedules to evaluate delay impacts and identifies and quantifies both owner and contractor delays (Zafar, 1996). This method evaluates the overall effect of all delays collectively, rather than examining each delay event independently (McCullough, 1999).

For projects with less demanding contractual requirements, where an as-planned schedule using the critical path method may not be created, only a bar chart diagram of the intended performance of the work together with an as-built program or records kept are adequate to perform the analysis. The as-planned vs. as-built method does not demand the creation of a logic linked as-planned, as-built, or contemporaneously updated programs as required in additive or subtractive methods. This makes the manipulation of the delay analysis results harder, as the analyst cannot incorporate a biased opinion into the analysis (Zafar, 1996). This method is well-suited for projects where it is simple to pinpoint the primary causes of delays, such as through a detailed comparison of scheduled versus completed tasks using a high-level Gantt chart (Farrow, 2007).

This method offers several advantages, including its simplicity, ability to consider changes in planned intentions, and reliance on a visual methodology that is free from manipulation. Furthermore, it is a cost-effective approach and is especially beneficial for pinpointing the likely sources of major delays (Farrow, 2007). However, it cannot identify the effects of each delay event separately because it lacks a systematic procedure (Arditi & Pattanakitchamroon, 2006). Only a comparison of the first activities between the as-planned and as-built schedule can give an indication of the delay and acceleration of an activity. All the early and late dates of succeeding task activities will change as a result of the impact that the first delay event has on the schedule. Consequently, comparison of the as-built and as-planned dates for those succeeding activities cannot indicate whether the activity was completed on time (Al-Gahtani & Mohan, 2011).

2.5.2 Impacted As-Planned

In the impacted as-planned method, also known as the what-if or adjusted baseline method, the analyst, after identifying the as-planned program, impacts the as-planned program by adding activities representing the delay events. It is considered that the contractor is entitled to a time extension based on the difference between the project completion date shown in the as-planned program and the date in the impacted as-planned program (Trauner, 2009).

The prerequisites of this method are an as-planned program, which is created using critical path method showing the planned intention of the contractor, and a selection of delay events (Farrow, 2007). The impacted as-planned method is generally considered the simplest and most affordable delay analysis method, but it does have important drawbacks, especially because it does not consider achieved progress or changes to the contractor’s planned intentions. The outcomes of this method represent the hypothetical impact of the simulated delays on the planned schedule (SCL, 2017).

Extension of time claims prepared by contractors using the impacted as-planned method usually consider employer-caused delays in the analysis (Arditi & Pattanakitchamroon, 2006). An analysis conducted based on only an as-planned schedule failed to convince judges that the delay actually affected the project completion (Arditi & Pattanakitchamroon, 2008).

2.5.3 Collapsed As-Built

In the collapsed as-built (CAB) method, a thorough analysis of all contemporaneous records and project documentation is conducted in order to develop a comprehensive as-built program. The delay events that affected the project are then subtracted or removed from the as-built program. Hence, the variance between the project completion date of as-built and collapsed as-built programs calculated by subtracting delay events from as-built program is considered to be the delay (Golparvar-Fard et al., 2011).

The CAB method is selected when a contractor does not have an approved as-planned program by the employer, or when creation of an as-planned program is not a requirement of the contract (Arditi & Pattanakitchamroon, 2006).

The CAB utilizes a simulation of a hypothetical situation based on CPM that reflects the contractor's real sequences and durations, rather than their intentions (Keane & Caletka, 2008). The collapsed as-built analysis is highly subjective and is subject to manipulation. It assumes that the as-planned intentions and productivities of the contractor to execute the work would be same as the actual ones (Zack, 2001). The analyst has to determine as-built logic relationships between activities to create an as-built program from contemporaneous records to conduct the analysis using the CPM. An as-built schedule relies on the actual dates of completed activities rather than the original network logic. The interpretation of this information can be manipulated due to the potential for the subjective interpretation of records, including logical sequencing and lag times (Arditi & Pattanakitchamroon, 2006). The as-built logic created to conduct this analysis is static in both as-built and collapsed as-built programs, which is not in line with actual situations because contractors usually change their intended sequence during the course of the project to mitigate delays, optimize resources, and so on. Thus, the CAB method does not show the effects of the delays at the time they arise, which may result in critical delays being overlooked in the project (Keane & Caletka, 2008).

During a contractor’s delay analysis using CAB, the analyst specifically considers only delays attributed to the employer in order to determine the effects of employer-caused delays on the project's completion milestones. Any delays caused by the contractor are not factored into the analysis. As a result, concurrent delays cannot be detected through a CAB analysis, highlighting a limitation of this method (Finke, 1999).

2.5.4 Time Impact Analysis

The time impact method relies on the assumption that the effect of delays on the project can be determined by running a series of analyses on updates of the work program. Time impact analysis comprises a structured procedure to assess the effects of delays using CPM principles. It evaluates the effects of delays on the work program by analyzing the program contemporaneously (Arditi & Pattanakitchamroon, 2006). Delay events are inserted into the CPM schedule in a chronological manner and their effects are identified (Bayraktar et al., 2012). This approach uses fragnets to analyze individual delay events. The durations of the delay events and their relationships with activities in the program are determined based on the project records kept contemporaneously. The delay event is then added into the program (Arditi & Pattanakitchamroon, 2006). The amount of delay caused by each delay event is then calculated by comparing the completion dates of the project before and after inclusion of each delay event into the program (Ndekugri et al., 2008).

The performance of time impact analysis requires extensive contemporaneous record-keeping. An as-planned program must be created using the critical path method; additionally, the program must be updated contemporaneously. The time impact method may not be suitable for projects that do not follow strict project management procedures, as the prerequisite data such as updated programs and extensive record-keeping may not be available (Arditi & Pattanakitchamroon, 2006).

The utilization of time impact analysis seems to be predominantly evident in large-scale projects, wherein expert consultants rely on updated network schedules to accurately reconstruct delays throughout the project timeline. This type of analysis demands a significant amount of data and resources, which may not always be feasible in certain construction projects due to their transient nature and constraints in time and budget that hinder the proper documentation of scheduling data. One widely accepted method of delay analysis by courts and arbitration boards is the TIA method because it has a systematic procedure that provides extensive detail (Arditi & Pattanakitchamroon, 2008). The method also addresses the changes in the contractor's intended sequence, as updated programs are used to analyze the time impact of delay events. Thus, the dynamic nature of project critical path is well recognized in the method (Baram, 1994). The major difference between the time impact method and the time slice windows analysis method is that the former is a prospective analysis and the latter is a retrospective analysis (Farrow, 2007).

2.5.5 Time Slice Windows Analysis

The primary concept behind time slice windows analysis (TSWA) involves dividing the overall duration of a project into manageable time periods, known as windows, and systematically analyzing the delays that occur within each window, with particular emphasis on the critical paths (Hegazy & Zhang, 2005). The first step in this method is to update the program at the of end of the first window time, based on the progress that has been achieved, including all the delays that occurred in that window, whereas the remaining work is planned according to the revised intentions at the time of the end of the window. The variance between the project completion date of the updated program at the end of the first window and the as-planned program gives the total delay in the project completion date as a result of the delays that occurred within the first window. This analysis is performed successively for all remaining windows to determine the impact of all delay events on project completion (Ndekugri et al., 2008). Next, the analyst thoroughly examines the project records to ascertain the delay events that may have led to the critical delay identified during each time window (SCL, 2017).

This method requires the analyst to verify or develop updated work programs at the end of each window that demonstrate actual progress of the work, including any delays that occurred until the end of the project or cut-off date of the extension of time claim (SCL, 2017). The criteria for selecting the size of these windows is determined based on key project milestones, the timing of main delay events, and the submission of revised or updated programs (Mehany & Grigg, 2016).

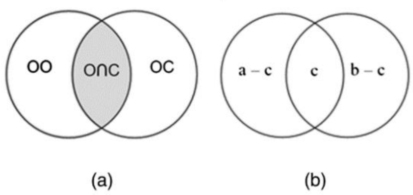
The main strength of time slice windows analysis is its capability to identify changes in the critical path during project execution. On the other hand, it is usually less cost effective because of the consumed time and the effort required by the analyst to conduct it (Ndekugri et al., 2008). This method is considered to be both 'observational' and at the same time 'dynamic.' The method is observational because it does not require or rely on a base CPM model which calculates delay based on the inclusion or subtraction of delay causes into the program. The approach relies on the effects of delays which are noticed in the contemporaneously updated programs (Keane & Caletka, 2008). The critical and near-critical paths are reviewed at the end of each window to identify the amount and cause of the delays that occurred in the window. Window sizes are usually selected weekly or monthly depending on the size of the project. Thus, the technique does not consider the fluctuation that may occur in the critical paths within a window. Due to the above-mentioned fluctuation, the technique loses sensitivity to the time at which the employer or contractor causes project delays within the window. It also loses sensitivity to the events of acceleration or the lost productivity occurring within a window. Hence, the sensitivity of the analysis decreases when window sizes are longer (Hegazy & Zhang, 2005).

2.5.6 Modified Delay Analysis Methods

2.5.6.1 Modified But-For Method for Delay Analysis

Mbabazi et al. (2005) proposed a modified but-for method (MBF) to overcome an important shortcoming of the traditional CAB related to identification of effects of concurrent delays of contractor and employer. The traditional CAB method concentrates on only one party’s delays, and these delays are subtracted from the as-built program to determine the effect of delays of the opponent party. Thus, effects of concurrent delays are overlooked. In the MBF, Venn diagram representation is utilized to calculate employer-culpable delays, contractor-culpable delays, and concurrent delays, as shown in Figure 1. First, both employer and contractor-culpable delay events are subtracted from the as-built program to find what would have been the unimpacted project completion date. Second, only contractor-culpable delay events are subtracted from the as-built program to determine what would have been the project completion delay if the delay was caused only by the employer. Last, only customer-culpable delay events are subtracted from the as-built program to determine what would have been the project completion delay if the delay had been caused only by the customer. After the calculation is done in these three steps, the effect of concurrent delays on the project completion date can be calculated with a simple mathematical equation based on the Venn diagram, as shown in Figure 1. The process is user-friendly for professionals and stands out for its inclusion of concurrent delays, resulting in fair and consistent delay analysis.

Case of two parties:



Removed Events	Resulting Project Duration	Venn Calculations	Project Delay Responsibilities
O + C	T_1	$T_0' - T_1 = a + b - c = OO + OC + O \cap C$	$OO = T_0 - T_2$
O	T_2	$T_0 - T_2 = a - c = OO$	$OC = T_0 - T_3$
C	T_3	$T_0 - T_3 = b - c = OC$	$O \cap C = T_2 + T_3 - T_0 - T_1$

T_0 = as-built duration   OO= Only Owner   OC = Only Contractor

(c)

Figure 1 Modified But-For Method – Calculation of Delay Responsibility

2.5.6.2 Isolated Collapsed But-For Delay Analysis Methodology

Yang and Yin (2009) developed the isolated collapsed but-for (ICBF) method by combining the general principles of traditional CAB and TSWA methods. The concept of dividing project duration into windows to find the cause of delays is more accurately taken from TSWA but the starting point of the analysis is the as-built program rather than the as-planned program as found in the traditional CAB method. After the cut-off date of each window is identified based on major delay events, available schedule updates, or major program logic changes, an adjusted schedule is created at the end of the first window that is closer to the project completion date. In the adjusted program, the duration of activities that fall before the cut-off date are kept the same as that of the as-built program and the duration of the remaining activities is reset to match the as as-planned program. The employer-culpable delay events are inserted into the adjusted program to determine the critical delay caused by the employer in that window. Then, the contractor-culpable delay events are inserted into the adjusted program to find the critical delay caused by the contractor in that window. This process is repeated for each selected window, and the results of each window are aggregated to attribute the responsibility of the overall project delay between both parties. Figure 2 shows the structural methodology of the ICBF method. The ICBF method has similar strengths to those of TSWA such as having systematic and dynamic methodology and its ability to identify concurrent delays. Furthermore, the ICBF method utilizes as-built schedule logic as the baseline, which makes it more reliable than TSWA when significant changes occur in planned sequence during the execution of the project because TSWA calculates the effect of delays prospectively at the end of each window. Compared to the traditional CAB method, the main strength of ICBF is that it can identify both contractor- and employer-culpable delays as well as concurrent delays.

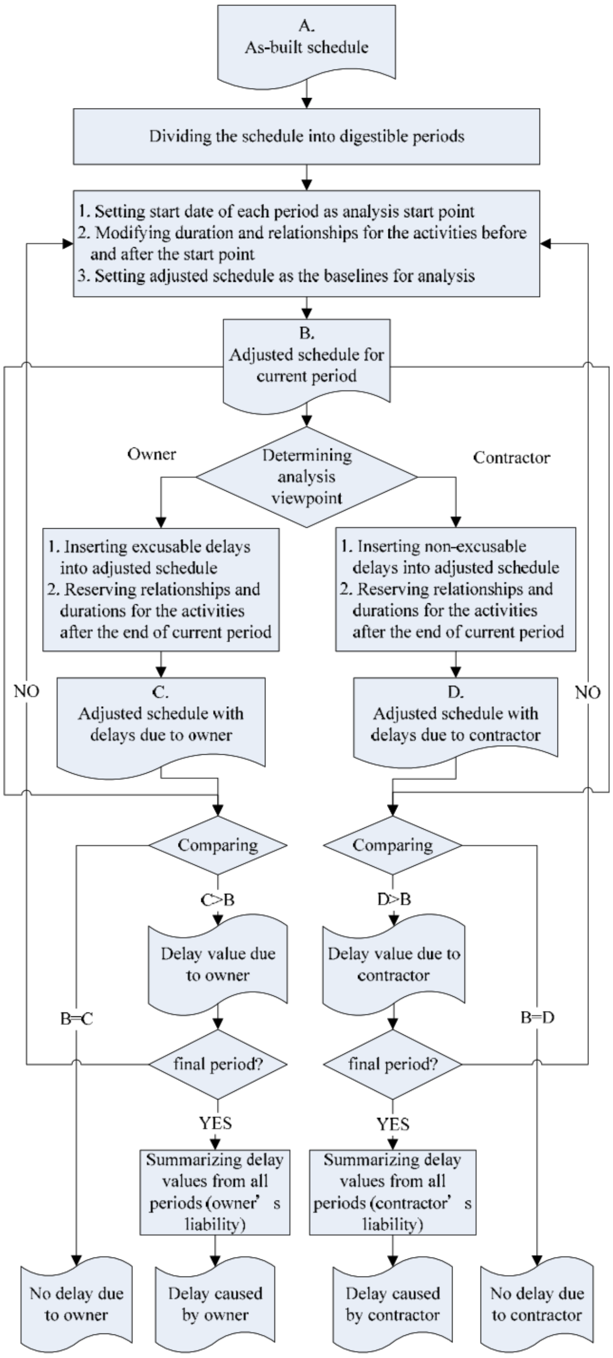
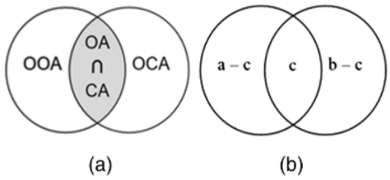


Figure 2 Systematic Methodology of the Isolated Collapsed But-For Method

2.5.6.3 Enhanced But-For Method to Apportion Delays and Accelerations

Bhih and Hegazy (2021) proposed an enhanced but-for method (EBFM) to overcome the shortcoming of the collapsed as-built/as-built but for method in identifying net project accelerations. The modified but-for method was utilized as a basis for enhanced but-for method due to the method's ability to calculate the effects of concurrent delays. Even though the modified but-for method is an upgraded method of the traditional method, it still has a drawback related to identification of accelerations for projects completed ahead of schedule. Thus, EBFM has been developed to overcome the shortcomings of traditional collapsed as-built analysis and takes into account not only the delays but also the accelerations in the program. EBFM uses the MBF delay computation for projects that only have delays in their project completion date. The extended analysis in case of net acceleration, on the other hand, has been formulated using a new set of equations based on Venn diagram representation, as shown in Figure 3. First, the schedule accelerations achieved by both employer and contractor are subtracted from the as-built program, and the overall project acceleration is calculated based on the variance between completion dates of as-planned and as-built programs. Second, schedule accelerations achieved by the employer are subtracted from as-built program, and the contractor's contribution to project acceleration is calculated as the difference between completion dates of as-planned and as-built programs. Last, schedule accelerations achieved by the contractor are subtracted from the as-built program, and the employer's contribution to project acceleration is calculated as the difference between the completion dates of the as-planned and as-built programs. Then, the equation, as shown in Figure 3, is solved in order to calculate the amount of acceleration concurrently achieved by the contractor and employer.

Case of two parties:



Removed Events	Resulting Project Duration	Venn Calculations	Project Acceleration Responsibilities
O + C	T_1	$T_1 - T_0^* = a + b - c = OOA + OCA + OA \cap CA$	$OOA = T_1 - T_3$
O	T_2	$T_1 - T_2 = b - c = OCA$	$OCA = T_1 - T_2$
C	T_3	$T_1 - T_3 = a - c = OOA$	$OA \cap CA = T_2 + T_3 - T_0 - T_1$

* T_0 = as-built duration OOA= Only-Owner Acceleration OCA = Only-Contractor Acceleration

(c)

Figure 3 Enhanced But-For Method – Calculation of Acceleration Responsibility

2.5.6.4 Modified Time Impact Analysis Method

Even though the time impact analysis method is considered to be one of the most reliable delay analysis methods, it is time-consuming and its performance requires extensive effort and data. Fan (2012) developed the modified time impact analysis method (MTIA), which benefits from the strengths of TIA, such as application of delays to the program in chronological order, but it requires significantly less effort to prepare and the presentation of the analysis results is much easier to understand and evaluate. The developed methodology has five stages, which are described as follows.

- Identification of delay events and evaluating the accountable party for each individual delay event
- Identification of impacted activities
- Creating a simplified program
- Analyzing the impact on the completion milestone after the effect of each delay event
- Aggregation of change in completion date resulting from each delay occurrence

The main feature which makes the MTIA analysis easy to perform and understand stems from the stage of generating a simplified schedule. Project programs in the construction industry tend to be highly complicated and consist of thousands of activities. Performance of the analysis on the overall project program is burdensome, and the result of the analysis is overly complicated. Thus, MTIA selects the network of activities that are identified as having been affected by the delay events so that the analysis will be easier to perform. Aggregation of change in completion date is then calculated by creating a network diagram of all the network paths that are affected by the delay events identified while assessing each delay event. Thus, the delays on the different paths, which might be concurrent, will not be overlooked. Fan (2012) performed the analysis on a case study whose program which contained 3,000 activities, which were simplified into 19 activities during MTIA without changing the result of the analysis, compared to TIA. However, the main disadvantage of this method is that if a delay event is not identified at the beginning of the analysis, the effect of that delay event cannot be seen during the analysis because the simplified network that is created only contains the affected activities from pre-determined delay events. Thus, MTIA may yield wrong results by overlooking the effects of important delay events.

2.5.6.5 FLORA New Forensic Schedule Analysis Technique

Nguyen and Ibbs (2008) developed a new forensic schedule analysis method, namely FLORA, that overcomes the drawbacks, such as float ownership, change in program logic, and the resource allocation of commonly used delay analysis methods. FLORA also takes the cascaded effects of delays into consideration as a secondary impact. Basically, FLORA takes the as-planned program and evenly distributes the total float values of activities to the employer and the contractor. The program is then updated at of start date of each delay event. Effects of delay events are analyzed as a first step and a delayed project completion date is calculated. A secondary analysis is then performed on the same updated program if there is a planned acceleration measure such as a change in the sequence of work or an additional delay due to resource overallocation. The revised project completion date is then recorded after the secondary analysis, and delays are attributed to the responsible party. If the delays only reduce the total float on the delayed activity, allocated float of the party that caused the delay is reduced. The process is repeated until all the identified delay events are analyzed. Figure 4 shows the process of FLORA in a flowchart. FLORA tackles a range of unresolved and overlooked issues in forensic schedule analysis. Its assessments adeptly capture the intricacies of float, logic, and resource allocation dynamics, making it suitable for both contemporaneous and retrospective analyses.

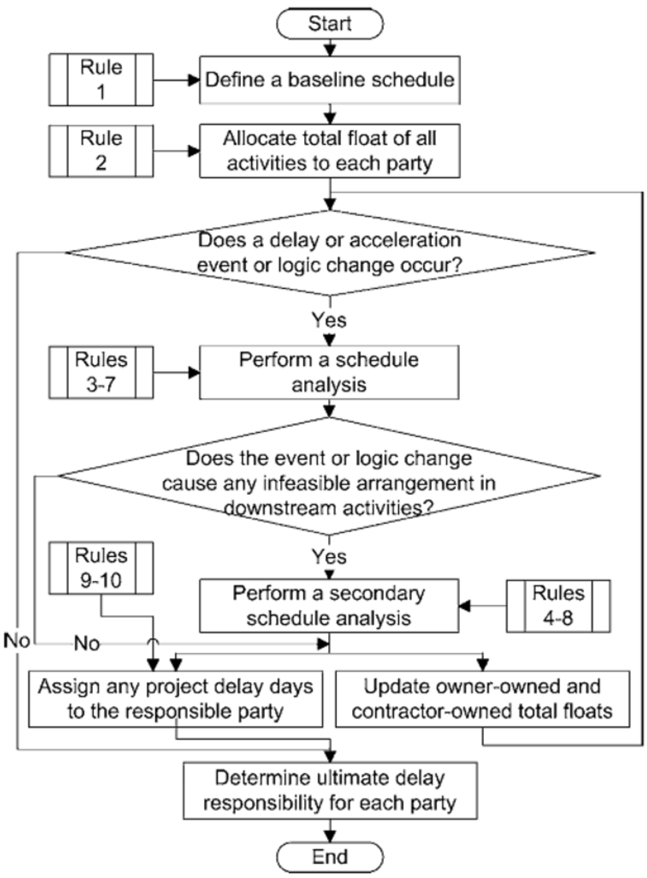


Figure 4 FLORA Delay Analysis Process Flowchart

2.5.6.6 Integrated Approach to Overcome Shortcomings in Current Delay Analysis Practices

Birgonul et al. (2014) have developed an integrated approach to overcome shortcomings in current delay analysis practices. Their study identified 17 shortcomings, which prompted the development of an integrated approach consisting of a comprehensive set of guidelines to address these shortcomings. Additionally, they devised a detailed flowchart that guides all involved parties through the project, from inception to completion. The specific shortcomings outlined in the study are as follows:

- Mistakes in planned productivity rates
- Productivity losses
- Ownership of float
- Critical path changes
- Concurrent delay
- Non-working days
- Net and concurrent effect
- Addition of new activity
- Deletion of existing activity
- Pacing delay
- Resource overallocation
- Rework
- Acceleration
- Mitigation
- Quantity increases for an activity
- Quantity decreases for an activity
- Network logic change in the program

Birgonul et al. (2014) introduced a series of guidelines aimed at addressing these shortcomings and achieving precise and dependable outcomes. This comprehensive methodology has introduced a fresh outlook on delay analysis practices. It takes into account every stage that contributes to an analysis and offers feasible remedies for any shortcoming identified at each stage, as illustrated in Figure 5.

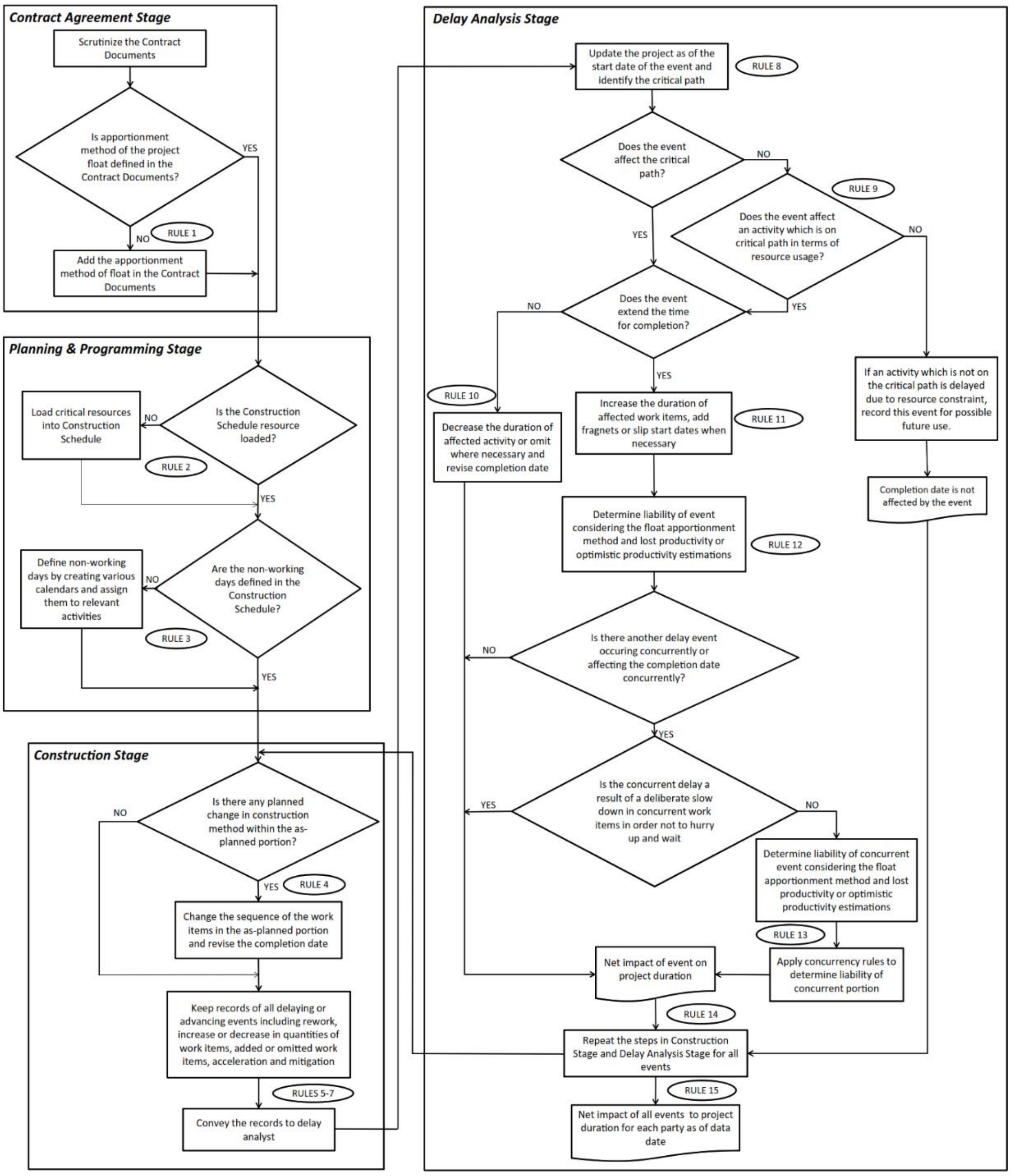


Figure 5 Integrated Approach to Overcome Shortcomings of Delay Analysis

2.5.6.7 Delay Analysis Method Using Delay Section

Kim et al. (2005) proposed a new methodology called "delay analysis method using delay section" (DAMUDS) as a means of overcoming two limitations of existing methods:

- Failure to accurately assess concurrent delays
- Failure to accurately assess accelerated activities

The DAMUDS method is an enhancement of the commonly employed time slice windows analysis. The authors conveyed their arguments by employing a case study as a demonstration. The main difference between TSWA and DAMUDS is that in the TSWA, window sizes are selected subjectively and in the DAMUDS window sizes are selected based on start and end date of delay events. It is burdensome to calculate the effect of concurrent delays separately in TSWA if there are some concurrent delay events that have different start and end dates within the same window. However, in DAMUDS, calculating the effect of each concurrent delay event is relatively easy because a separate window is defined whenever there is a concurrency. Figure 6 illustrates the concept of selection of delay sections in a simple project. Additionally, DAMUDS has a process for calculating the effects of accelerated activities on the project completion date in an easier way. Accelerated activities are identified as contractor's float (CF), and the CF concept is carried out until the completion of the analysis. However, both weaknesses, accurate calculation of effect of concurrent delay and accelerated activities, of TSWA mentioned in the study can be resolved if appropriate window sizes are selected in the TSWA analysis.

2.5.6.8 Delay Analysis Under Multiple Baseline Updates

Hegazy and Menesi (2008) developed delay analysis under multiple baseline updates method to overcome some of the shortcomings of the TSWA method. The method considers multiple baseline updates necessitated by shifts in activity durations and their interdependencies, along with the consequences of resource overallocation. A daily window size is employed in the model to capture variations in critical and near-critical paths, while also providing a clear depiction of progress data for precise allocation of delays and accelerations to project stakeholders. The main advancement of this method over that of TSWA is that it considers resource constraints as part of the delay analysis and accounts for the effects of each delay on remaining activities due to changes in resource allocation. Furthermore, the baseline program is revised whenever there is a change in schedule logic or acceleration measure planned for remaining activities, which results in better assessment of the effects of future delay events. Therefore, the method that has been suggested provides a clear depiction of scheduled events and possesses a strong capability to deliver precise and verifiable results.

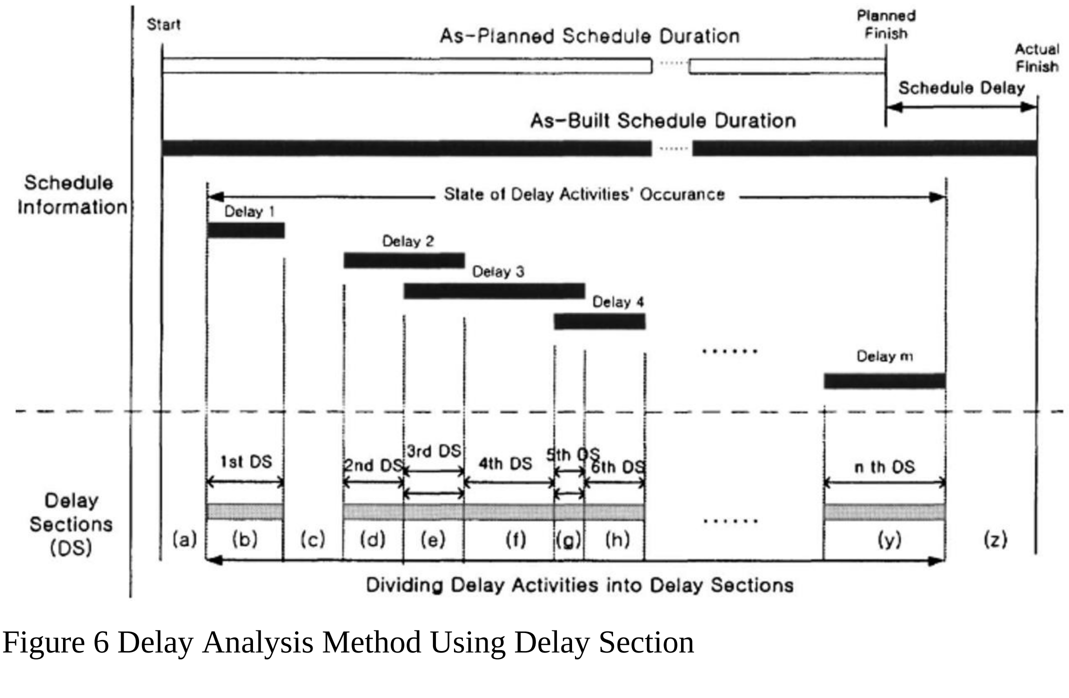


Figure 6 Delay Analysis Method Using Delay Section

2.5.6.9 Enhanced Daily Windows Delay-Analysis Technique

Bhih and Hegazy (2021) have developed an enhanced daily windows analysis (EDWDA) that unites the strength of the daily windows method to identify critical path fluctuations and the strength of the modified but-for method to detect accelerations and concurrent delays. The EDWDA follows the step-by-step analysis of daily windows and, within each day, apportions a multiday project consequence using the modified but-for method. Daily windows are selected in the EDWDA in order to capture all the changes in the critical path and to accurately define the cause of delays. However, daily windows analysis has a drawback with regard to identifying complex situations that involve multiple delay and acceleration events or events that can cause more than a one-day effect on the project completion date within the same window. To address these drawbacks of daily windows analysis, the EDWDA embraced the latest developments in the but-for analysis method where a Venn diagram was utilized to calculate the effects of both contractor and employer delays as well as concurrent delays. The proposed EDWDA technique proceeds day by day. On each day, the program is updated until the end of the day. Then, based on the duration and relationship of the remaining activities in the program, completion date of the project is calculated. All delay events, contractor-culpable delay events, and employer-culpable delay events are then subtracted from the modified program respectively. Effects of delays caused by each party are then calculated via the modified but-for method using the mathematical formula created by Venn diagram presentation by Mbabazi et al. (2005). The effectiveness of the EDWDA methodology was demonstrated through case studies that revealed its superior performance relative to its precursor methods.

2.5.6.10 New Delay Analysis Method Using Modified Schedule and Modified Updated Schedule

Cevikbas et al. (2022) have developed a new delay analysis method using modified schedule and modified updated schedule (MSvsMUS) that overcomes the shortcomings of commonly used delay analysis methods. The shortcomings of commonly used methods were identified by focus group discussions held with industry experts who have hands-on experience in delay claims. The discussions revealed that critical path analysis, incorporation of achieved progress, and critical path changes were the most common shortcomings of many of the existing methods. Furthermore, in most of these methods, only the effect of employer-culpable delay events are taken into consideration to substantiate the extension of time claims. Additionally, certain types of activity relationships, actual improvements, and further delays made by contractors on the planned excusable compensable delays and excusable non-compensable delays are usually ignored by these methods. To overcome the identified shortcomings, the proposed method is structured in a way that can take into consideration the various types of program logic links among the critical activities, comprise intricate numerical formulas, and compute the differences between the modified schedule (MS) including planned fragnets and modified updated schedule (MUS) including actualized fragnets periodically.

The study contained first-time identification of two major shortcomings of existing delay analysis methods:

- A delay analysis method considering start-to-start and finish-to-finish relationships has not been developed and verification of all existing delay analysis methods are always done using a program logic built only to consider finish-to-start relationships.
- None of the delay analysis methods can calculate any acceleration or additional delays made by the contractor on the planned delays of excusable compensable and excusable non-compensable delays such as variations in orders, site instructions, or adverse weather conditions.

The MSvsMUS method makes the analyses in windows same as that of TSWA. The main difference of the method from TSWA is that the delays that are subjected to extension of time are inserted into the program before the update at of end of window to obtain modified schedule. Later, the program is updated at of end of window with the actual progress information to obtain modified updated schedule so that any further delay or acceleration made by the contractor can be analyzed by comparing the modified schedule and modified updated schedule. Figure 7 shows the main principles of the proposed MSvsMUS method.

The MSvsMUS method was tested in a case study, and it has proven to yield more accurate results in comparison with the commonly used delay analysis methods in the construction industry. Thus, MSvsMUS has been deemed a good alternative for analyzing delays when the as-planned program, updated programs, and list of excusable and compensable delay events are available.

2.5.6.11 Method for Calculating Schedule Delay Considering Lost Productivity

Productivity losses are frequently cited as a leading factor contributing to project delays within the construction industry. However, only a few studies have concentrated on the effect of lost productivity on schedule delay analysis. Additionally, amicable agreements between contractor and employer could not be factored into loss of productivity claims since it is difficult to quantify the effect of disruption. Thus, to analyze the effect of lost productivity on the time schedule required the development of structured delay analysis methodology. Lee et al. (2005) proposed a delay analysis method that takes productivity losses into consideration. The methodology put forth a number of key concepts related to delay and productivity, encompassing elements such as planned and actual work duration, factors contributing to the impact, lost productivity, the timeframe of lost productivity, variability in start and finish times, among others. Building upon these concepts, a comprehensive delay analysis framework and mathematical equations were devised to enhance the precision of schedule delay evaluations. This methodology was showcased and put into practice in a specific project to demonstrate its effectiveness. The case study findings indicate that this approach offers a more systematic method for examining intricate delay scenarios, ultimately yielding more thorough insights into schedule delays.

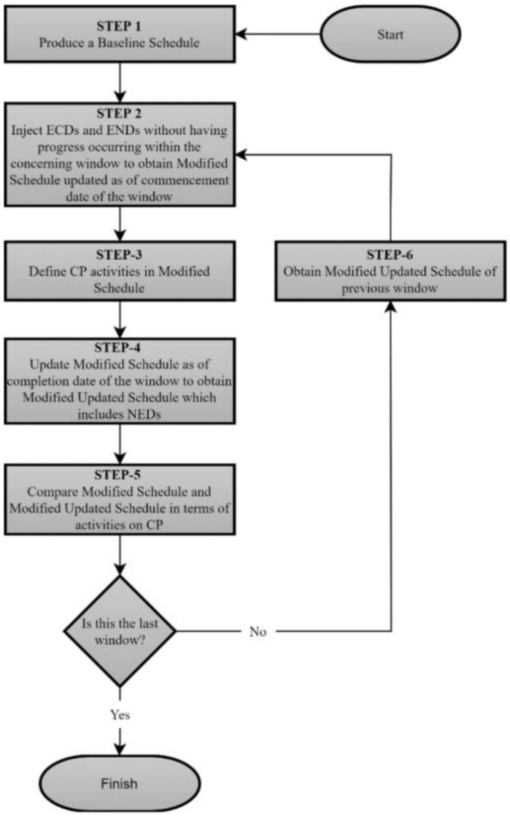


Figure 7 Process Flowchart of MSvsMUS Delay Analysis Method

2.5.6.12 Quantifying the Delay from Lost Productivity

A decrease in labor productivity indicates the need for additional resources to complete a specific task, potentially leading to longer timelines for completion.

While decreased labor productivity can cause delays, it is not usually considered in estimates for damages caused by delays in the analysis. Assessing the impact of reduced labor productivity on a project program can be challenging. A systematic approach for analyzing schedule delays is necessary to accurately determine the extent of delay caused by decreased labor productivity. Mikhail and Serag (2019) proposed a method based on the measured mile, the most widely endorsed method for quantifying productivity loss, to find the effect of lost productivity on project program. The measured mile technique involves comparing similar activities during periods of project impact and non-impact in order to determine the reduction in productivity attributable to specific delays. This method relies on extrapolating the actual hours worked. In this method, the type of quantifiable work that delayed the project completion date needs to be selected, such as concreting work, steel installation work, and so on. The unimpacted and impacted periods then need to be identified from the project records. Later, information needs to be collected on spent man-hours and executed work quantity from the records in line with identified unimpacted and impacted periods. Then, the productivity rates of unimpacted periods and impacted periods must be defined. Next, the percentage of productivity loss in each period is calculated using the productivity rates of unimpacted and impacted periods which are later converted into the schedule delays. In conclusion, utilizing the measured mile analysis is contingent upon having contemporaneous documentation and insights from the project. Therefore, when managing large-scale construction projects, it is imperative to maintain thorough project records from the inception of the project that accurately reflect contemporaneous project documentation provided by individuals who are directly engaged in the construction process.

2.6 Issues in Analysis of Delays

2.6.1 Program Availability

The as-planned schedule established at the beginning of a project should precisely outline a contractor's original intentions for executing its complete scope of work. Since the as-planned schedule shows how and when the work would have been performed had there been no changes or delays, it may serve as the starting point to conduct an analysis of delays (Finke, 1999).

Availability of the as-planned program is a prerequisite to all commonly used delay analysis methods, such as impacted as-planned, as-planned vs. as-built, time impact and windows analysis, but not the collapsed as-built method. Even though the collapsed as-built method does not require an as-planned program, the availability of the as-planned program makes the analysis more reliable because a more precise definition can be made of delay events that are to be subtracted from as-built program by comparing the duration of activities in as-planned and as-built programs (Keane & Caletka, 2008).

If the as-planned program is unavailable, the analyst might be required to develop or revise the as-planned program. The greater the level of retrospection employed by analysts, the higher the likelihood that the findings will be contested due to potential bias or lack of reliability (Farrow, 2007).

2.6.2 Record-keeping

Contractors should maintain accurate and detailed as-built records of activities taking place on the construction site in order to provide evidence to support their claims for extension of time and additional costs associated with project prolongation (Shabbar et al., 2017). Crucial to delay analysis is thoroughly examining the records that will serve as the foundation for the analysis results. Therefore, the maintaining of comprehensive records and the different types of record-keeping necessary is heavily emphasized (Keane & Caletka, 2008). When seeking compensation for a project delay, it is essential to analyze the specific event that caused the delay in relation to the critical and near-critical paths of the project. This information should be clearly outlined in the project documentation (Levin, 2016). The presentation of evidence plays a vital role in the resolution of claims and potential arbitration proceedings. The outcomes of many decisions rest upon the precision and trustworthiness of as-built records. Therefore, meticulous record-keeping and proper documentation are essential for efficient project execution. Specifically, the availability of scheduling information is vital for the preparation and resolution of claims associated with time extensions. Subsequently, claim consultants should be engaged in examining the causes and effects of events that may be subject to claims (Seo et al., 2021).

Many types of construction contracts typically mandate that contractors submit periodic record-based documentation, such as issuing a notice of intent to file a claim for time and/or additional cost within a reasonable timeframe following the triggering event. These notice stipulations are commonly tied to a directive to maintain up-to-date records that are subject to occasional review by the employer's representative. Failure by contractors to adhere to these provisions often results in no entitlement to extension of time or monetary compensation (Keane & Caletka, 2008).

It is essential to create and uphold precise and comprehensive project record, as it can be crucial in supporting and justifying a claim (Levin, 2016). The subsequent documents are essential records that should be kept for the entirety of the project:

- The as-planned program
- Contemporaneously updated programs, which are updated at regular intervals throughout the execution of a project
- Daily progress records of contractor and subcontractors

- Correspondences, whether in the form of letters or emails, that serve to record any delay events or issues
- Logs tracking all documents such as RFIs, engineering documents, shop drawings, contract changes and so on
- Minutes of meetings of meetings held with employer or subcontractors

Negotiating and agreeing upon the appropriate types of records for assessing claims are crucial for both the employer and contractor as they enter into a contract (Aibinu, 2009). Different conclusions are reached when parties analyze claims using different information and assumptions or interpret information in a different way. This is commonly seen in delay and disruption claims, where inadequate record-keeping is recognized as a significant contributing factor to the issue (Vidogah & Ndekugri, 1998). ElNemr and Mohamed (2019) assert that within the industry, it is infrequent for all parties involved to proactively engage in maintaining comprehensive records of delays before implementing a delay analysis method. As a result, a large and complex project with inadequate record-keeping procedures is particularly at risk of having delay events manipulated while performance of a delay analysis. According to Jergeas and Hartman (1994), based on their experience in compiling documentation for claims on behalf of contractors, contractors commonly overlook safeguarding their contractual interests. This oversight often stems from insufficient comprehension and proactive oversight of the contract terms, or inadequate maintenance of accurate records.

2.6.3 Notification of Delays

The identification of claims should be promptly followed by notification. In certain commonly used construction contracts, it is explicitly stated that a contractor must provide written notice of any delays or claims as a prerequisite for seeking an EOT and cost compensation. Failure by the contractor to comply with this notice requirement within the specified timeframe, as indicated in the contract, would result in the contractor being deprived of entitlements to an extension of time and/or compensation (Aibinu, 2009). Neglecting to provide appropriate and prompt notification consistently serves as the primary initial defense of an employer (Levin, 2016). The primary aim of a contractor's notice is to formally notify the employer or contract administrator of the existence of a problem that may warrant the contractor to claim an extension of time and/or additional cost compensation. A contractor's notice is an alert to the employer about the matter. When notification is done by the contractor, the employer is provided with the chance to thoroughly investigate and address the implications of the delay event. In circumstances where a delay cannot be prevented, prompt communication from the contractor regarding the event may allow the contract administrator to evaluate the contractor' claims and settle it in a timely and proactive manner, rather than it becoming an after-the-fact claim evaluation (Bramble & Callahan, 1992).

Under English law, there has been a reluctance to rigorously enforce notification requirements due to the prevention principle. If a contractor fails to provide notice of employer-culpable delays within the specified time limit as outlined in the contract, their entitlement to an extension of time may be forfeited. Additionally, the contractor may not be able to seek damages for the delay. This could also potentially result in the contractor being liable to pay liquidated damages to the employer if they extend the completion date due to delays caused by the employer that were not properly notified. In such scenarios, the employer would profit from their own wrongdoing, inadvertently breaching the prevention principle (Lal, 2002).

2.6.4 Float Ownership

Fortunately, delays can be mitigated by providing flexibility in the timing to execute activities. For activities that have float, delays are considered non-critical, and this flexibility already exists. Allocation of float as a contingency reserve can thus become a vital strategy for minimizing risk for the entire project (Su et al., 2018). Ownership of float and its utilization can lead to significant disagreements, particularly when a project experiences delays (Prateapusanond, 2003). At the commencement of a project, it is crucial to establish the ownership of float to mitigate potential conflicts and prevent delays and budget overruns. Regrettably, contracts frequently lack explicit clauses on the allocation of float, leading to disagreements and legal disputes. In general, there are three main concepts regarding the ownership of total float: the employer's, contractor's, and project's ownership (Shabbar et al., 2017).

Contracts typically stipulate that float is the property of the project or is allocated on a "first-come, first-served" basis. In essence, if an employer-driven delay consumes the available float, the contractor is held responsible for delays caused by the contractor that extend the project completion date, delays that could have been absorbed if the project still had remaining float. Likewise, if a contractor consumes all available float at the project's outset, the employer then assumes responsibility for any delays resulting from changed orders, a circumstance that could have been avoided had the contractor not consumed the entire float (Arditi & Pattanakitchamroon, 2006).

A study conducted among 46 professionals in the United Kingdom, who are employees of employers, contractors, and claims consultants, revealed that most participants were of the opinion that contractors should be granted sole authority over float allocation. Conversely, only a limited number of owners favored the idea of float distribution based on a first-come, first-served approach (Scott et al., 2004). De la Garza et al. (1991) share the same view with the British professionals that float should be solely advantageous for the contractor, and they suggest float should be treated as a tradable commodity. This would mean that the contractor has right to sell the float if the employer requests to use up the float. Their article contains the procedure for transforming the total float value into a selling price. Householder and Rutland (1990) propose that the allocation of float be designated for the party that experiences a loss or gain due to fluctuations in the project cost. In other words, in fixed-price contracts, the contractor bears the ultimate responsibility or benefit from project cost, and therefore should have sole control over float usage. Conversely, in cost-plus contracts where the employer bears the ultimate risk or benefit from project cost, the employer should be allowed to control project float in order to reduce costs. Al-Gahtani and Mohan (2007) propose a new method for management of float for delay analysis that sets logical rules for the allocation of total float. If total float is reduced due to delay events, the responsible party will be discredited total float for delays to the impacted activity and will gain or lose the total float of successor activities. Another compromise solution is suggested by Pasiphol and Popescu (1994), who propose a qualitative method for allocating total float into each activity before starting the execution of a project. Ibbs and Nguyen (2008) put forth an approach outlining guidelines for delay analysts on the allocation of float ownership. The technique suggests a shared distribution of total float according to predetermined criteria. Any changes in total float arising from acceleration or delay are linked to the accountable party's float for the specific activity, resulting in corresponding adjustments.

2.6.5 Concurrent Delay

Concurrent delay is defined as two delays that occur simultaneously (Trauner, 1990). However, the simultaneous occurrence of two or more delay events is rare. A more common usage of the term 'concurrent delay' concerns the situation where two or more delay events arise at different times, but the effects of these event are felt at the same time. SCL (2017) defines this situation as "concurrent effect." In the event of a concurrent delay or concurrent effect, had either of the delays not occurred, the project completion date would have been delayed by the other party anyway (Stumpf, 2000).

Concurrent delay analysis is a highly intricate and challenging aspect of schedule delay analysis. Analyzing concurrent delays that commence and conclude simultaneously may be straightforward. Nevertheless, the majority of delays have varying start and end dates, requiring the analyst to evaluate numerous factors associated with each delay to determine its impact on the overall project duration. Factors to be considered include the delay's connection to the critical path of the project, the total float times of subsequent activities affected by the delay, the overlap of delays, and the method of selecting delay analysis increments (Kim et al., 2005).

The parties usually utilize concurrent delays as an argument in claims against each other (Greiner, 2006). The burden of proof regarding claims lies with the claimant; the contract may not address issues of concurrent delay; intentional concurrent delays may be created through pacing; and the complexities of acceleration, concurrency, and intertwined delays can pose challenges in managing concurrent delay scenarios (Livengood, 2017).

The SCL (2017) Delay and Disruption Protocol addresses the issue of concurrency concerning the entitlement to EOT and monetary compensation as follows. Where contractor delay in completion occurs concurrently with employer delay in completion, the contractor's concurrent delay should not reduce any extension of time (EOT) due. Where employer risk events and contractor risk events occur sequentially but have concurrent effects, here again, any contractor delay should not reduce the amount of EOT due to the contractor as a result of the employer delay. If the contractor incurs additional costs that are caused both by employer delay and contractor delay, then the contractor should only recover compensation if it is possible to separate the additional costs caused by the employer delay from those caused by the contractor delay. In most cases, this will mean that the contractor will be entitled to compensation only for any period in which the employer delay exceeds the duration of the contractor delay.

2.6.6 Pacing Delay

Spinelli and Zack (2014) provided a definition for pacing delay as slowing down of project work by one party in the contract in response to delays or potential delays caused by the other party, in order to ensure consistent progress in accordance with the updated project program.

A contractor may opt to strategically adjust the timing of activities not deemed critical by slowing their progress to align with the pace of delayed critical path activities. SCL (2017) suggests that in the event that the contractor plans to delay activities that are not on the critical path of the project, it is advisable to inform the employer and the contract administrator of such intentions, along with the rationale behind this decision. Pacing, as opposed to concurrent delays, is characterized by a deliberate decision by the performing party to progress at a slower pace with the awareness of other delays happening simultaneously. Concurrent delays, on the other hand, occur independently and without a deliberate choice to impede progress (Spinelli & Zack, 2014).

In the absence of definitions for the terms "concurrent delay" and "pacing delay," it is likely that most employers and employer representatives will perceive an alleged "pacing delay" as another term for "concurrent delay" - making the issue more complicated and more difficult to resolve (Spinelli & Zack, 2014). Delaying work deliberately to create a voluntary concurrent delay, known as a pacing delay, can serve as a valid justification against allegations of concurrency in a legal setting (Munvar et al., 2020). However, the lack of pacing delay notice denies the employer the opportunity to mitigate the employer's damages and may cause a court or arbitration panel to deny the pacing delay claim (Spinelli & Zack, 2014).

A pacing delay can have the practical benefit of mitigating the delay damages that the employer may be liable for. Coordinating the delay with a predominant delay can help avoid unnecessary expenses related to maintaining the execution of the project according to planned progress (Keane & Caletka, 2008).

If either a contractor or an employer's professional team seeks to rely on this argument, then the following should be demonstrated by the relevant party:

- Knowledge of a critical delay caused by the other party
- Proof of a deliberate decision to slow down the progress
- Notification to the employer/contractor that its work would be paced so as not to cause further delay or disruption to the work

2.6.7 Mitigation

According to Keane and Caletka (2008), mitigation refers to the actions taken to lessen the impact of a delay or disruption expected from an event, changed circumstance, or factor, regardless of its origin being attributable to the employer or contractor. It is suggested that 'mitigation' as a contractual obligation should be read as 'reasonable steps to minimize loss' but not 'unreasonable steps that result in a greater loss' (SCL, 2017). The process of minimizing the impact of delay claims begins with promptly identifying potential issues (Yates & Epstein, 2006). The obligation to mitigate delays entails that a contractor must modify their schedule to lessen the possible time impact of an employer-culpable delay, provided that such schedule adjustments do not significantly impact the contractor's overall program or expenses. The main distinction between mitigation and acceleration lies in the fact that the obligation to mitigate does not necessitate the contractor to invest its own funds to lessen the effect of the delay (Levin, 2016). Careful documentation of schedule mitigations is crucial for establishing the timing of and reasons behind such measures, understanding their impact on the work program, and determining the associated costs. In the event that there are extra expenses linked to the implementation of mitigation measures, it is advisable for the contractor to inform the employer about the proposed measures in order to give the employer the choice to either accept or decline the contractor's proposal. It is important to consider that the determination of what qualifies as "reasonable" mitigation will be affected by various factors such as the expenses related to the delay, the expenses associated with mitigation efforts, and the information available to the contractor at the time of the delay (Finke, 1999).

2.6.8 Acceleration

Acceleration is the action taken by a contractor to hasten the progress of a project in order to recover time lost or to finish the project earlier than originally planned.

Contractors often accelerate their work to make up for delays that have occurred (Levin, 2016).

The issue of schedule acceleration poses a significant challenge for construction contractors, as it significantly disrupts the planned allocation of resources. Schedule acceleration refers to having an increased workload within a given timeframe or having a decreased timeframe for completing the same amount of work. The contractors face significant economic implications due to lower productivity rates caused by acceleration measures, as reduction in labor productivity can range from 20% to 45% (Thomas, 2000). Thus, providing the proper motivation for acceleration and cooperation through incentives and disincentives are essential. This encourages the contractors to allocate the required resources to execute the project in an accelerated manner. Owners need to develop procedures and criteria for the use of incentives and disincentives on planned acceleration projects (Anderson et al., 2011).

A contractor can accelerate voluntarily, constructively, or pursuant to a directive by the owner, the details of which are explained below:

- Under voluntary acceleration, the contractor takes voluntary action to expedite progress, demonstrating self-initiative in addressing delays and striving to finish tasks ahead of schedule.
- Ordered, or directed, acceleration refers to when the employer specifically asks the contractor to speed up the progress of the work.
- Constructive acceleration occurs when the contractor is forced to attempt to achieve a completion date that is earlier than what should be required under the contract because the employer did not grant an extension for excusable delay in a timely manner.

Disputes arise when the employer denies a request for an extension of time, or when the employer suggests in their interactions with the contractor that the contractor must accelerate the progress of the project to prevent being subject to liquidated damages. Instead of depending solely on the right to a time extension and then attempting to reclaim funds withheld by the employer due to delays, the contractor may view the employer's actions as necessitating an acceleration to meet the original project deadline. In such a scenario, the contractor could make a claim for "constructive acceleration" against the employer, aiming to recover all expenses - both direct and indirect - accrued during the accelerated work period (Riad et al., 1994).

Acceleration should be benefited by the party responsible for incurring its cost, so employer-instructed acceleration should be acknowledged to the employer, while contractor-voluntary acceleration should be acknowledged to the contractor (Bhih & Hegazy, 2021). Using one party’s acceleration to make up for that party’s delays is the logical practice (Zhang & Hegazy, 2005). If the contractor is instructed to accelerate the project, time gained thanks to acceleration measures can be reduced from the effects of delays caused by employer given that the additional costs are compensated by the employer (Birgonul et al., 2014).

2.6.9 Prolongation Costs

Keane and Caletka (2008) defined the prolongation costs as the time-related costs that are experienced due to the extended duration of the work as a result of a delay or delay events. The contractor is entitled to receive compensation for extended time and site overhead expenses due to employer-caused delays as stated in standard contract forms, such as those from the International Federation of Consulting Engineers (FIDIC) (Shabbar et al., 2017).

Where the effects of employer-culpable delays and contractor-culpable delays are concurrent, then the contractor should only be compensated when the additional costs occurred due to employer-culpable delays can be distinguished from those that occurred due to contractor-culpable delays. Unless there is a contractual clause related to rates of prolongation costs, the contractor should be compensated according to its actual costs. The aim is to bring the contractor to the same financial status as if there were no employer-culpable delay in the project. Once it is agreed that contractor is entitled to be compensated for prolongation costs, the compensation amount should be calculated by reference to the period of occurrence of critical delay events, not by reference to the extended period at the end of the contract (SCL, 2017).

If a contractor is prevented by the employer from completing the project earlier than the contractual completion date, the contractor may seek to be compensated for any prolongation costs associated with delayed planned completion even if the delayed completion is earlier than contractual completion date. The contractor should be entitled to such prolongation cost if the employer was aware of the contractor's intention to complete the project earlier than contractual completion date stated in the as-planned program (Scott et al., 2004).

Shabbar et al. (2017) highlighted that primarily in the cases of employer-related delays, even though the employer grants the extension of time to the contractor, the employer tends to avoid compensation of prolongation costs caused by their delay. Entitlement of contactor prolongation costs is crucial to avoiding claims, disputes, and overruns.

CHAPTER 3

CASE STUDY

SCL (2006) released The Great Delay Analysis Debate in which a delay scenario was created and delay analysis was performed using the following four commonly used methodologies:

- As-planned versus as-built
- Impacted as-planned
- Collapsed as-built
- Time impact analysis

Furthermore, the results of each delay analysis methodology were compared, and advantages and disadvantages of each methodology were discussed.

The same case study related to a delay scenario was analyzed using the time slice windows analysis technique in this thesis study. The result of the time slice windows analysis is compared with other techniques used in the Great Delay Analysis Debate, and advantages and disadvantages of the technique are discussed.

3.1 Records on Delay Scenario

3.1.1 Contract Documents

The project consists of the construction of a below-ground, reinforced concrete slab designed to be waterproofed with an applied finish.

Under the contract, the Contractor bears the risk of:

- Carrying out the work with good-quality materials and workmanship
- Supplying labor, the plant, and materials

- Keeping the excavations free of water
- Setting-out

The contractor is entitled to start on 15 March 2004 and must complete the project by 27 April 2004. There is a liquidated damage fee for failure to complete on time for each day of delay.

If the Contractor is caused delay by any of the following, then the Employer must extend the date for completion by a fair and reasonable period:

- Variations
- Errors or ambiguities in the description of the work
- A failure to supply information drawings or details in due time

3.1.2 Program Records

3.1.2.1 The As-Planned Program

The Contractor does not intend to work weekends or over national holidays. Based on that, the calendar is created in the scheduling software, as shown in Figure 8.

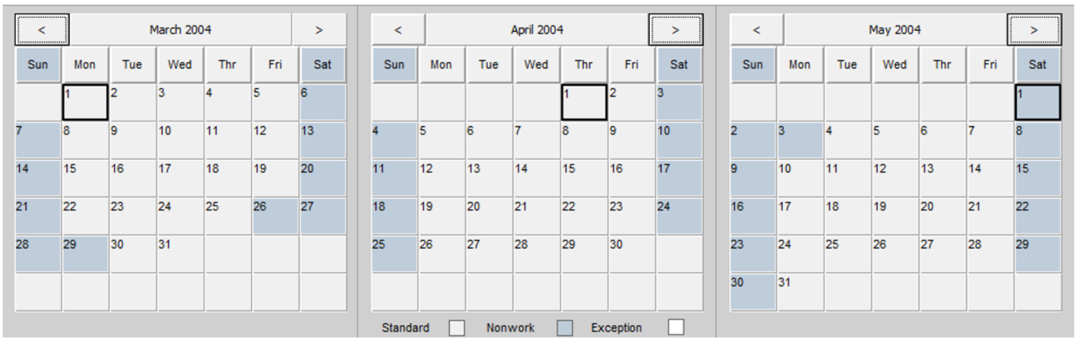
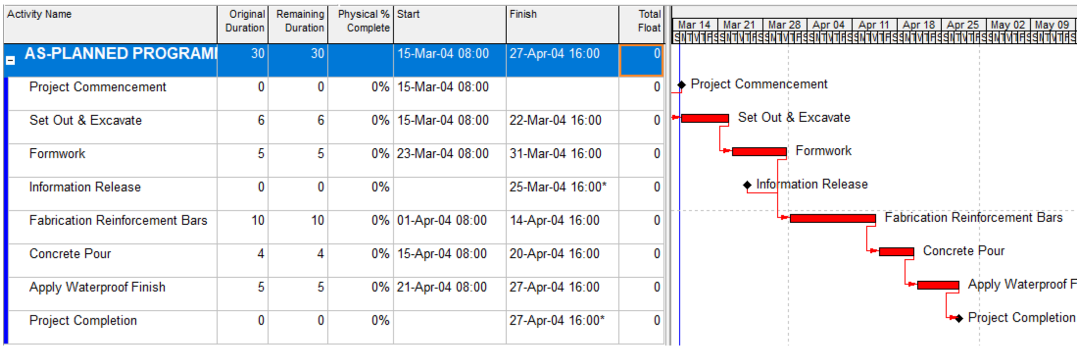


Figure 8 As-Planned Program Work Calendar

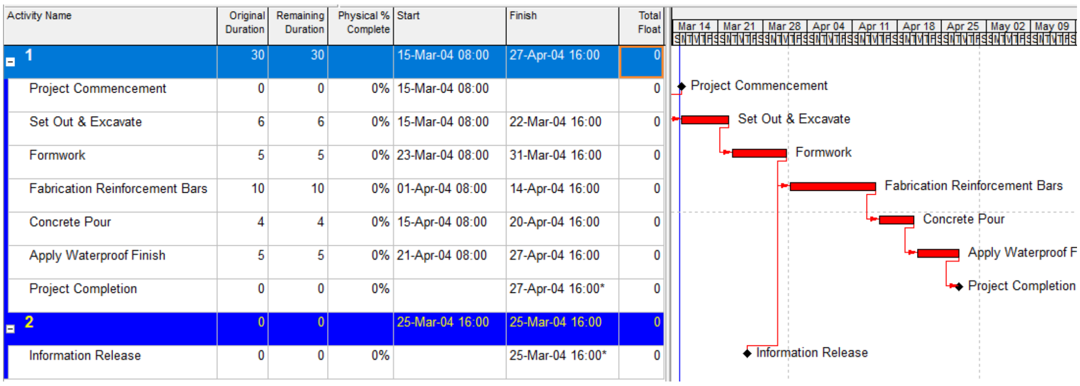
The Contractor's as-planned program is illustrated in Figure 9.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
AS-PLANNED PROGRAMI	30	30		15-Mar-04 08:00	27-Apr-04 16:00	0
Project Commencement	0	0	0%	15-Mar-04 08:00		0
Set Out & Excavate	6	6	0%	15-Mar-04 08:00	22-Mar-04 16:00	0
Formwork	5	5	0%	23-Mar-04 08:00	31-Mar-04 16:00	0
Information Release	0	0	0%		25-Mar-04 16:00*	0
Fabrication Reinforcement Bars	10	10	0%	01-Apr-04 08:00	14-Apr-04 16:00	0
Concrete Pour	4	4	0%	15-Apr-04 08:00	20-Apr-04 16:00	0
Apply Waterproof Finish	5	5	0%	21-Apr-04 08:00	27-Apr-04 16:00	0
Project Completion	0	0	0%		27-Apr-04 16:00*	0

Figure 9 Contractor’s As-Planned Program

The as-planned program consists of two paths, both of which are critical as their total float is 0 days. The float paths taken from scheduling software are shown below in Figure 10.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	30	30		15-Mar-04 08:00	27-Apr-04 16:00	0
Project Commencement	0	0	0%	15-Mar-04 08:00		0
Set Out & Excavate	6	6	0%	15-Mar-04 08:00	22-Mar-04 16:00	0
Formwork	5	5	0%	23-Mar-04 08:00	31-Mar-04 16:00	0
Fabrication Reinforcement Bars	10	10	0%	01-Apr-04 08:00	14-Apr-04 16:00	0
Concrete Pour	4	4	0%	15-Apr-04 08:00	20-Apr-04 16:00	0
Apply Waterproof Finish	5	5	0%	21-Apr-04 08:00	27-Apr-04 16:00	0
Project Completion	0	0	0%		27-Apr-04 16:00*	0
2	0	0		25-Mar-04 16:00	25-Mar-04 16:00	0
Information Release	0	0	0%		25-Mar-04 16:00*	0

Figure 10 Float Paths of As-Planned Program

The first float path, which is also the longest path of the project, comprises the following activities:

- Project Commencement
- Set Out & Excavate
- Formwork
- Fabrication Reinforcement Bars
- Concrete Pour

- Apply Waterproof Finish
- Project Completion

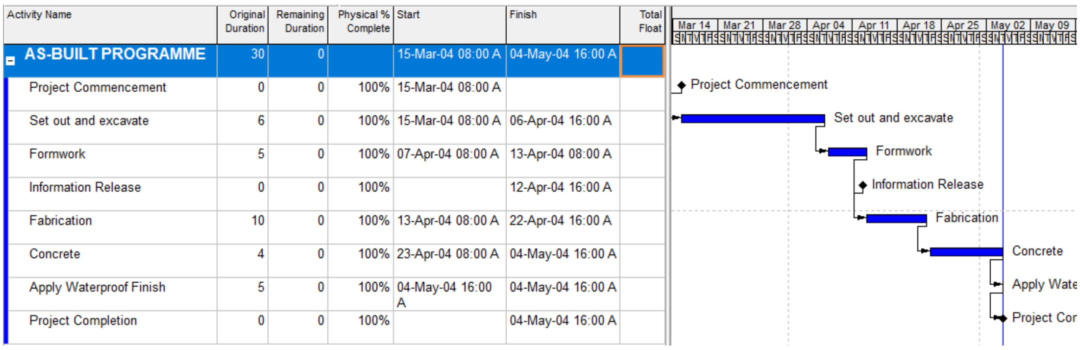
The second float path, which is also a critical path, entails the following activities:

- Information Release
- Fabrication Reinforcement Bars
- Concrete Pour
- Apply Waterproof Finish
- Project Completion

Information Release activity is an Employer activity, which must be completed 2 working days before the start of Fabrication Reinforcement Bars activity to allow time for procurement of reinforcement bars. Due to that, Information Release activity has a relationship of finish to start with a 2-day lag with Fabrication Reinforcement Bars activity in the as-planned program.

3.1.2.2 The As-Built Program

The as-built program of the project is illustrated in Figure 11. The project is completed on 04-May-04 with a delay of 7 calendar days compared to the as-planned program and contractual date.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
AS-BUILT PROGRAMME	30	0		15-Mar-04 08:00 A	04-May-04 16:00 A	
Project Commencement	0	0	100%	15-Mar-04 08:00 A		
Set out and excavate	6	0	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5	0	100%	07-Apr-04 08:00 A	13-Apr-04 08:00 A	
Information Release	0	0	100%		12-Apr-04 16:00 A	
Fabrication	10	0	100%	13-Apr-04 08:00 A	22-Apr-04 16:00 A	
Concrete	4	0	100%	23-Apr-04 08:00 A	04-May-04 16:00 A	
Apply Waterproof Finish	5	0	100%	04-May-04 16:00 A	04-May-04 16:00 A	
Project Completion	0	0	100%		04-May-04 16:00 A	

Figure 11 The As-Built Program

3.1.3 Progress Records

Figure 12 shows the Contractor’s daily progress records.

The following is a summary of the records:

- During the excavations there were adverse weather conditions. The progress was disrupted, and excavation work was delayed. The Contractor’s pumps were broken down and the excavations collapsed, which necessitated rework and caused delay.
- The Employer changed the design of waterproofing from waterproof finish to Admix to be used in the concrete. The planned duration for waterproofing was 5 days and this activity was cancelled. The concreting duration was 4 days and concreting with Admix was actually placed in 7 days.
- Some parts of the excavation were performed in the wrong area caused by the mistakes in the dimensions of slab reinforcement drawing. The Employer noticed the mistake in excavation and instructed the Contractor to perform additional excavation and backfill the incorrect excavation.
- Information release related to reinforcement bars by the Employer were done on 12 April but had been scheduled as 25 March in the as-planned program.
- The Contractor performed several acceleration measures such as working during the weekend and assigning additional resources to the activities.

Date	Day	Description	Activity ID	Cum.% comp.
15-Mar-04	Monday	Site set up completed full mobilisation	1000	100
		Started setting out. Couldn't find site layout drawing so used slab drwg.	1010	7
16-Mar-04	Tuesday	Excavation . Rained off late morning	1010	10
17-Mar-04	Wednesday	No work today torrential rain all day	1010	10
18-Mar-04	Thursday	No progress -rain.	1010	10
		Discussed waterproofing with Employer. Instructed not to proceed with applied finish. We to advise on alternatives	E1060	
19-Mar-04	Friday	Good progress today	1010	
		Provided Employer with suggestions for waterproofing.	E1070	25
20-Mar-04	Saturday			
21-Mar-04	Sunday			
22-Mar-04	Monday	Weather clearing up started late morning good progress	1010	35
		Employer considering Admix - requested test data	E1070	40
23-Mar-04	Tuesday	rained off pm.	1010	50
		E says setting out is wrong mistake in slab drwg. shows one bay too many	E1100	
24-Mar-04	Wednesday	heavy rain hampering progress, pumping ground water	1010	55
		considering setting out problem	E1110	
25-Mar-04	Thursday	heavy rain no progress, pump breakdown repaired pm.	1010	55
		Correcting setting out problem	E1110	
26-Mar-04	Friday	Bank Holiday. Pumping excavations	1010	
27-Mar-04	Saturday	Pumping excavations	1010	
28-Mar-04	Sunday	Pumping excavations	1010	
29-Mar-04	Monday	Bank Holiday. Pumping excavations	1010	
		Should have received rebar schedules	1030	
		Test data for Admix requested from BRE	E1080	
30-Mar-04	Tuesday	Excavations collapsed, pumps failed over weekend	1010	40
		Recommence excavation in new area	E1110	50
31-Mar-04	Wednesday	Pumping and clearing collapsed exc.	1010	40
		Complete new excavation	E1110	100
01-Apr-04	Thursday	Weather fine good progress	1010	55
		Formwork for fill in redundant excavation	E1110	100
02-Apr-04	Friday	Weather showery progress maintained	1010	70
		Mass concrete fill to redundant exc.	E1110	100
03-Apr-04	Saturday			
04-Apr-04	Sunday			
05-Apr-04	Monday	Weather fine good progress	1010	85
06-Apr-04	Tuesday	Excavations completed today pumps still working	1010	100
07-Apr-04	Wednesday	2 Joiners start formwork.Admix data sent to CA.	1020	15
08-Apr-04	Thursday	Formwork proceeding slowly request more joiners	1020	30
09-Apr-04	Friday	2 more joiners arrived.Good progress	1020	60
10-Apr-04	Saturday			
11-Apr-04	Sunday			
12-Apr-04	Monday	Formwork nearly finished ready to start rebar	1020	95
		Bar bending schedules arrived (at last!)		
		Instruction received to use Admix.checking with suppliers.		
13-Apr-04	Tuesday	2 joiners am complete outstanding formwork	1020	100
		Commence rebar fabrication 2 steelfixers. Order placed for Admix delivery expected 22Apr	1030	10
14-Apr-04	Wednesday	Rebar Steelfixers have requested overtime	1030	20
15-Apr-04	Thursday	Rebar Overtime approved for weekend	1030	30
16-Apr-04	Friday	Rebar	1030	40
17-Apr-04	Saturday	Rebar (12hrs weekend working)	1030	55
18-Apr-04	Sunday	Rebar (12hrs weekend working)	1030	70
19-Apr-04	Monday	Rebar incorrect fixings caried out over w/e	1030	80
20-Apr-04	Tuesday	Rebar redo part reinfocement	1030	87
21-Apr-04	Wednesday	Rebar progress poor no enthusiasm	1030	95
22-Apr-04	Thursday	Rebar Completed	1030	100
		Admix arrives.	E1180	
23-Apr-04	Friday	Started concreting only achieved two pours.	1040	15
24-Apr-04	Saturday			
25-Apr-04	Sunday			
26-Apr-04	Monday	Concrete 2 pours	1040	20
		Admix Not good progress, there seems to be some difficulty in blending	E1190	
27-Apr-04	Tuesday	Concrete 2 pours	1040	30
		Admix Rep visited Admix now added to premix	E1190	
28-Apr-04	Wednesday	Concrete 3 pours	1040	45
		Admix We seem to have got the hang of this now. Much better progress	E1190	
29-Apr-04	Thursday	Had to reject a load of concrete, could only achieve 1 pour	1040	50
		Admix	E1190	
01-May-04	Saturday			
02-May-04	Sunday			
03-May-04	Monday	Bank Holiday.		
04-May-04	Tuesday	Concrete 3 pours	1040	100
		Admix	E1190	

Figure 12 Contractor's Daily Progress Records

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3.2 Analysis of Delays

3.2.1 Time Slice Windows Analysis

Determining window sizes is crucial when performing time slice windows analysis. The sensitivity of the analysis decreases when bigger window sizes are used due to fluctuations that occur in the critical paths and accelerations and slowdowns within the window are not detected. On the contrary, the cost of the analysis increases when smaller window sizes are used due to increased effort required of the analyst. In addition, record-keeping requirements also increase when smaller window sizes are used in the analysis and as-built records may dictate a selection of a bigger window size.

In this case study, the analysis is done by using daily windows for following reasons:

- Simplicity of the project
- Short duration of the project
- To avoid missing any change, acceleration, or slowdown in the critical path
- Availability of daily progress records

This study analyzed not only what would be the outcome of time slice windows delay analysis method for the project, but also what would the benefit of the method be if it was used during the project execution as a delay management method as well. Using delay analysis methods during the project is beneficial for the project mainly due to following reasons:

- The impacts of the delay events are analyzed as they occur.
- Contractual delay notification requirements can be fulfilled by the Contractor as delays and their impacts become known when they occur.
- Extension of time requests can be made by the Contractor and assessed by the Employer as close in time as possible to the delay events, which will eliminate disputes occurring at the end of the project.

- The project time schedule can be revised based on the granted EOT to mitigate any unnecessary cost.
- Acceleration measures can be taken by the Contractor if critical delays are caused by the Contractor.
- The Employer can request that the Contractor accelerate the work and compensate acceleration costs if critical delays are caused by the Employer.
- As the Contractor has a general duty to mitigate the effect of Employer delays, it can take reasonable steps to mitigate the impacts of Employer delays.

Figure 13 shows the detailed flowchart of time slice windows analysis performed on the delay scenario. Main steps of the flowchart are summarized as following:

1. First, the as-planned program is updated with the progress of one day according to daily progress records provided at Figure 12.
2. Multiple float paths leading to the Project Completion milestone are reviewed to determine the impact on the critical and near-critical paths.
3. The project completion date in the updated program is compared with the as-planned program.
4. The events causing the delay, including the liable party, are identified and incorporated into the program as delay events.
5. The summary of the outcome of the window analysis is recorded into a tabulation which contains information such as updated project completion date, critical delay, concurrent delay, and liability.
6. In the next windows, all the above steps are repeated, but instead of the as-planed program, the updated program from the previous window is used. When delay analysis is finished on all windows, the program becomes the as-built program.

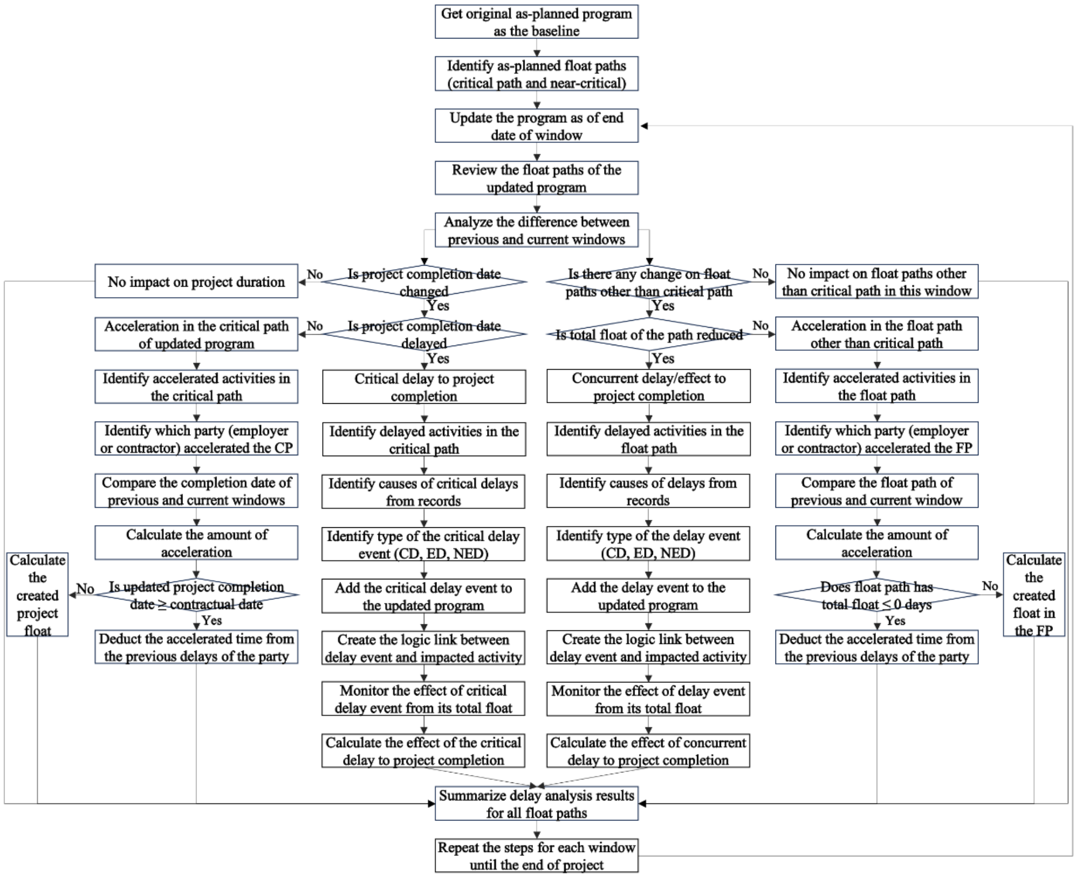


Figure 13 Flowchart of Time Slice Windows Analysis Performed on the Delay Scenario

3.2.1.1 Window 1 – From 15 March 2004 08:00 to 16 March 2004 08:00

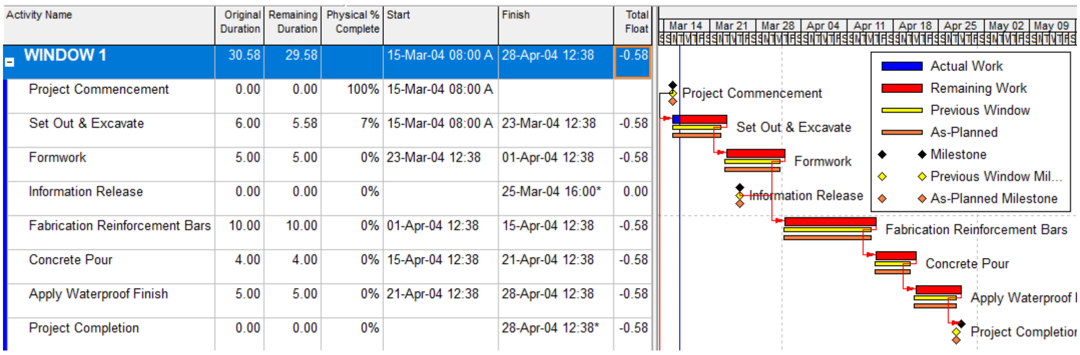
As also shown in Figure 12, the daily progress records for 15-Mar-04 were as follows:

- Mobilization is fully completed so that Project Commencement activity can be completed on time in the program.
- Setting Out & Excavation activity started on time on 15-Mar-04. However, the Contractor stated that it could not find the drawing of the site layout. Due to the unavailability of layout drawing, the slab drawing is being used for

setting out. Actual progress of Setting Out & Excavation activity is reported as 7%.

The achieved progress for Set Out & Excavate activity is less than planned because the activity's planned duration was 6 days. Hence, progress of 16.67% is planned to be achieved each day. Calculation of remaining duration of activities is done according to earned value analysis. Since, 7% of an activity, which has a planned duration of 6 days is completed, the earned value in terms of duration is calculated as 0.42 days, which means that the estimated remaining duration is 5.58 days.

Figure 14 shows the updated program for Window 1. The project completion date is shifted to 28-Apr-04, which is one day later than the project completion date in contract and as-planned program. The delay is considered as 1 day even though total float shows -0.58 days. This is because the delay is calculated based on the difference between the actual completion date and the contractual completion date.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 1	30.58	29.58		15-Mar-04 08:00 A	28-Apr-04 12:38	-0.58
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	5.58	7%	15-Mar-04 08:00 A	23-Mar-04 12:38	-0.58
Formwork	5.00	5.00	0%	23-Mar-04 12:38	01-Apr-04 12:38	-0.58
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00
Fabrication Reinforcement Bars	10.00	10.00	0%	01-Apr-04 12:38	15-Apr-04 12:38	-0.58
Concrete Pour	4.00	4.00	0%	15-Apr-04 12:38	21-Apr-04 12:38	-0.58
Apply Waterproof Finish	5.00	5.00	0%	21-Apr-04 12:38	28-Apr-04 12:38	-0.58
Project Completion	0.00	0.00	0%		28-Apr-04 12:38*	-0.58

Figure 14 Updated Program for Window 1

Figure 15 shows the float paths to Project Completion milestone in the updated program. The delay impacted only Float Path 1, which starts from Set Out & Excavate and completes with Project Completion Milestone. There is no delay in Float Path 2 as evidenced by the 0-day total float value.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	30.58	29.58		15-Mar-04 08:00 A	28-Apr-04 12:38	-0.58
Set Out & Excavate	6.00	5.58	7%	15-Mar-04 08:00 A	23-Mar-04 12:38	-0.58
Formwork	5.00	5.00	0%	23-Mar-04 12:38	01-Apr-04 12:38	-0.58
Fabrication Reinforcement Bars	10.00	10.00	0%	01-Apr-04 12:38	15-Apr-04 12:38	-0.58
Concrete Pour	4.00	4.00	0%	15-Apr-04 12:38	21-Apr-04 12:38	-0.58
Apply Waterproof Finish	5.00	5.00	0%	21-Apr-04 12:38	28-Apr-04 12:38	-0.58
Project Completion	0.00	0.00	0%		28-Apr-04 12:38*	-0.58
2	0.00	0.00		25-Mar-04 16:00	25-Mar-04 16:00	0.00
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00

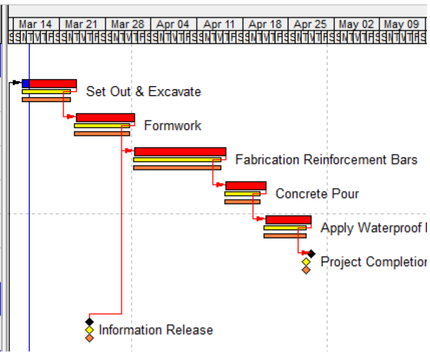


Figure 15 Float Paths of Updated Program for Window 1

In Window 1, the activity that delayed the Project Completion milestone is Set Out & Excavate activity. When the records are analyzed, it becomes evident that the activity has been delayed due to the low progress caused by Contractor. A delay event is introduced to the program as Contractor's Low Progress, which is classified as a non-excusable delay. The delay event is linked to Set-Out & Excavate activity as it affected the progress of this activity. Hence, the delay event is shown in the critical path. Figure 16 shows the updated program of Window 1, including the non-excusable delay event related to Contractor's low progress.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 1	30.58	29.58		15-Mar-04 08:00 A	28-Apr-04 12:38	-0.58
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	5.58	7%	15-Mar-04 08:00 A	23-Mar-04 12:38	-0.58
Formwork	5.00	5.00	0%	23-Mar-04 12:38	01-Apr-04 12:38	-0.58
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00
Fabrication Reinforcement Bars	10.00	10.00	0%	01-Apr-04 12:38	15-Apr-04 12:38	-0.58
Concrete Pour	4.00	4.00	0%	15-Apr-04 12:38	21-Apr-04 12:38	-0.58
Apply Waterproof Finish	5.00	5.00	0%	21-Apr-04 12:38	28-Apr-04 12:38	-0.58
Project Completion	0.00	0.00	0%		28-Apr-04 12:38*	-0.58
DELAY EVENTS	0.00	0.00		15-Mar-04 08:00 A	16-Mar-04 08:00	-0.58
NED-1: Contractor's Low Progress	0.00	0.00	0%	15-Mar-04 08:00 A	16-Mar-04 08:00	-0.58

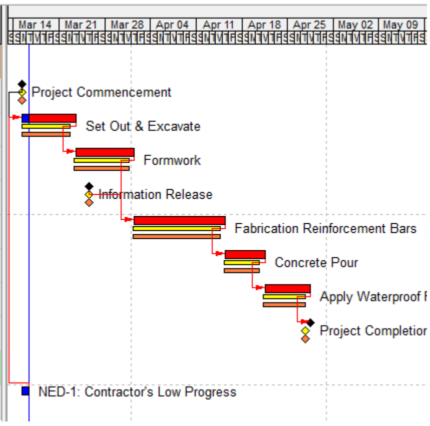
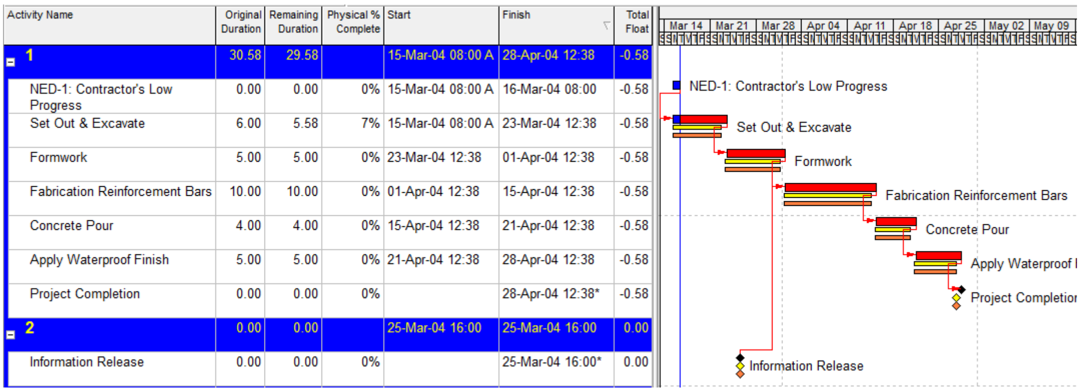


Figure 16 Updated Program for Window 1 Including Delay Event

Figure 17 shows that the delay event NED-1: Contractor's Low Progress is part of the critical path and causes a delay to project completion as it is included in Float Path 1 and has a total float value of -0.58 days, which is same as total float of Project Completion milestone.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	30.58	29.58		15-Mar-04 08:00 A	28-Apr-04 12:38	-0.58
NED-1: Contractor's Low Progress	0.00	0.00	0%	15-Mar-04 08:00 A	16-Mar-04 08:00	-0.58
Set Out & Excavate	6.00	5.58	7%	15-Mar-04 08:00 A	23-Mar-04 12:38	-0.58
Formwork	5.00	5.00	0%	23-Mar-04 12:38	01-Apr-04 12:38	-0.58
Fabrication Reinforcement Bars	10.00	10.00	0%	01-Apr-04 12:38	15-Apr-04 12:38	-0.58
Concrete Pour	4.00	4.00	0%	15-Apr-04 12:38	21-Apr-04 12:38	-0.58
Apply Waterproof Finish	5.00	5.00	0%	21-Apr-04 12:38	28-Apr-04 12:38	-0.58
Project Completion	0.00	0.00	0%		28-Apr-04 12:38*	-0.58
2	0.00	0.00		25-Mar-04 16:00	25-Mar-04 16:00	0.00
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00

Figure 17 Float Paths of Update Program for Window 1 Including Delay Event

The results of Window 1 of the delay analysis is shown in a summary format in Figure 18. There is a 1-day non-excusable delay on the Project Completion milestone in this window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 1

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	NED-1: Contractor's Low Progress	27-Apr-04	27-Apr-04	28-Apr-04	1	0	0	1		28-Apr-04															
Info. Release to Project Comp.	No Impact This Window	No Delay This Window	27-Apr-04	27-Apr-04	27-Apr-04	0	0	0	0																	

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | Contractual Project Completion Milestone

Figure 18 Time Slice Windows Analysis Results for Window 1

3.2.1.2 Window 2 – From 16 March 2004 08:00 to 17 March 2004 08:00

As also shown in Figure 12, the daily progress records for 16-Mar-04 were as follows:

- Excavation work progress was disrupted by the rain. Cumulative actual progress of Set Out & Excavation activity is reported as 10%, which is again lower than the planned progress.

Figure 19 shows the updated program for Window 2. The project completion date is shifted to 29-Apr-04, which means there is a 1-day delay compared to the previous Window, and a 2-day delay compared to the as-planned program. The delay was caused by Contractor's Low Progress on Set Out & Excavation activity, so that type of delay is a non-excusable delay.

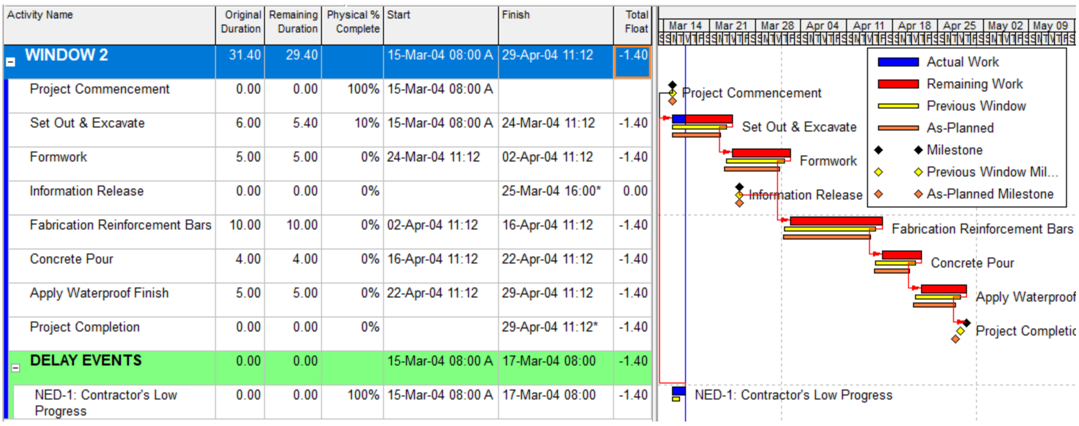
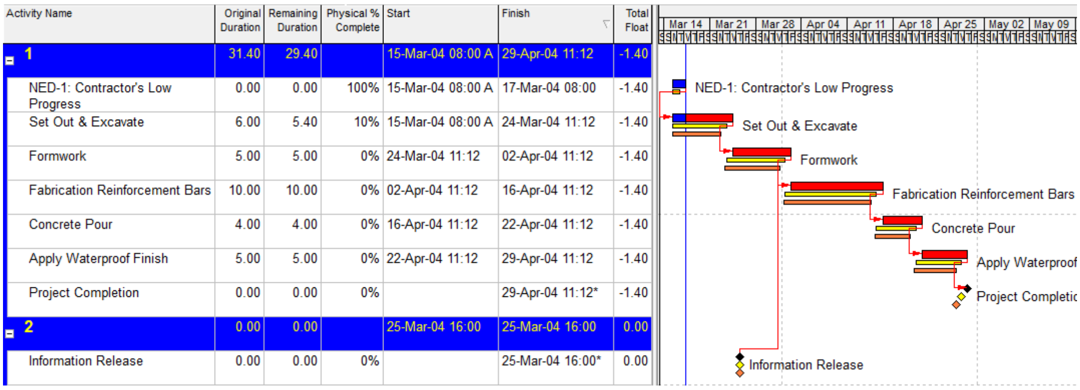


Figure 19 Updated Program for Window 2

Figure 20 shows the float paths to the Project Completion milestone on the updated program. The delay impacted only Float Path 1, which starts from the activity Set Out & Excavate and completes with Project Completion milestone. There is no delay in Float Path 2 as evident by 0-day total float value. The delay event NED-1: Contractor's Low Progress also appears in Float Path 1, which shows that it causes a critical delay to completion.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	31.40	29.40		15-Mar-04 08:00 A	29-Apr-04 11:12	-1.40
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00	-1.40
Set Out & Excavate	6.00	5.40	10%	15-Mar-04 08:00 A	24-Mar-04 11:12	-1.40
Formwork	5.00	5.00	0%	24-Mar-04 11:12	02-Apr-04 11:12	-1.40
Fabrication Reinforcement Bars	10.00	10.00	0%	02-Apr-04 11:12	16-Apr-04 11:12	-1.40
Concrete Pour	4.00	4.00	0%	16-Apr-04 11:12	22-Apr-04 11:12	-1.40
Apply Waterproof Finish	5.00	5.00	0%	22-Apr-04 11:12	29-Apr-04 11:12	-1.40
Project Completion	0.00	0.00	0%		29-Apr-04 11:12*	-1.40
2	0.00	0.00		25-Mar-04 16:00	25-Mar-04 16:00	0.00
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00

Figure 20 Float Paths of Updated Program for Window 2

The results of Window 2 of the delay analysis are shown in a summary format in Figure 21. There is a 2-day non-excusable delay on the Project Completion milestone at the end of this window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 2

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	NED-1: Contractor's Low Progress	27-Apr-04	28-Apr-04	29-Apr-04	2	0	0	2			29-Apr-04														
Info. Release to Project Comp.	No Impact This Window	No Delay This Window	27-Apr-04	27-Apr-04	27-Apr-04	0	0	0	0																	

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 21 Time Slice Windows Analysis Results for Window 2

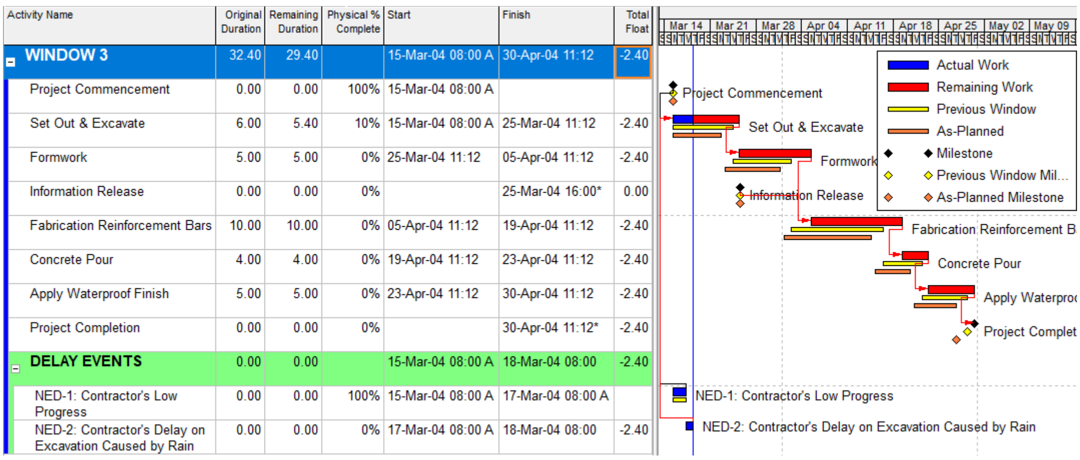
3.2.1.3 Window 3 – From 17 March 2004 08:00 to 18 March 2004 08:00

As also shown in Figure 12, the daily progress records for 17-Mar-04 were as follows:

- No progress was achieved on Set Out & Excavation activity due to torrential rain. Progress of excavation is reported as 10%, which is same as the previous window.

The contract document states that Contractor is responsible for keeping the excavations free of water. This can be interpreted as meaning that the Contractor needs to take all necessary measures to continue the work as per the plan even in rainy weather. SCL (2017) states in the Delay and Disruption Protocol that adverse weather conditions can be assessed as excusable delay, which means that the Contractor is entitled to an extension of time but not to compensation for prolongation costs. However, there is no evidence that the weather conditions were exceptional so that the delay could be considered as excusable delay. Thus, the delay related to the stoppage of the Set Out & Excavation activity caused by rainy weather is considered as non-excusable delay in the delay analysis.

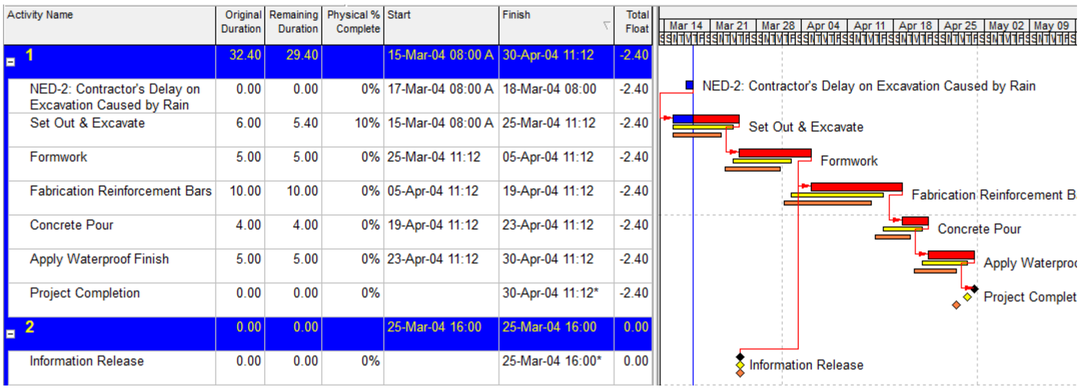
Figure 22 shows the updated program for Window 3. The project completion date is shifted to 30-Apr-04, which means there is a delay of 1 calendar day compared to the previous window, and a 3-calendar-day delay compared to the as-planned program. The delay occurred due to stoppage of the Set Out & Excavation activity caused by rainy weather. Activity related to this non-excusable delay event is created in the updated program as NED-2: Contractor's Delay on Excavation Caused by Rain. The delay event is linked with the Set Out & Excavate activity as it impacted the progress of excavation.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 3	32.40	29.40		15-Mar-04 08:00 A	30-Apr-04 11:12	-2.40
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	5.40	10%	15-Mar-04 08:00 A	25-Mar-04 11:12	-2.40
Formwork	5.00	5.00	0%	25-Mar-04 11:12	05-Apr-04 11:12	-2.40
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00
Fabrication Reinforcement Bars	10.00	10.00	0%	05-Apr-04 11:12	19-Apr-04 11:12	-2.40
Concrete Pour	4.00	4.00	0%	19-Apr-04 11:12	23-Apr-04 11:12	-2.40
Apply Waterproof Finish	5.00	5.00	0%	23-Apr-04 11:12	30-Apr-04 11:12	-2.40
Project Completion	0.00	0.00	0%		30-Apr-04 11:12*	-2.40
DELAY EVENTS	0.00	0.00		15-Mar-04 08:00 A	18-Mar-04 08:00	-2.40
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	0%	17-Mar-04 08:00 A	18-Mar-04 08:00	-2.40

Figure 22 Updated Program for Window 3

Figure 23 shows the float paths to the Project Completion milestone on the updated program. The delay impacted only Float Path 1, which starts from the activity Set Out & Excavate and completes with Project Completion milestone, because Float Path 2 has a 0-day total float. The delay event NED-2: Contractor's Delay on Excavation Caused by Rain also appears in Float Path 1, which shows that it caused a critical delay to completion.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	32.40	29.40		15-Mar-04 08:00 A	30-Apr-04 11:12	-2.40
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	0%	17-Mar-04 08:00 A	18-Mar-04 08:00	-2.40
Set Out & Excavate	6.00	5.40	10%	15-Mar-04 08:00 A	25-Mar-04 11:12	-2.40
Formwork	5.00	5.00	0%	25-Mar-04 11:12	05-Apr-04 11:12	-2.40
Fabrication Reinforcement Bars	10.00	10.00	0%	05-Apr-04 11:12	19-Apr-04 11:12	-2.40
Concrete Pour	4.00	4.00	0%	19-Apr-04 11:12	23-Apr-04 11:12	-2.40
Apply Waterproof Finish	5.00	5.00	0%	23-Apr-04 11:12	30-Apr-04 11:12	-2.40
Project Completion	0.00	0.00	0%		30-Apr-04 11:12*	-2.40
2	0.00	0.00		25-Mar-04 16:00	25-Mar-04 16:00	0.00
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00

Figure 23 Float Paths of Updated Program for Window 3

The results of Window 3 of the delay analysis are shown in a summary format in Figure 24. There is 3-day non-excusable delay on the Project Completion milestone at the end of this window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 3

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays: Tot.	CD	ED	NED	27-Apr-04 … 13-May-04
Set Out & Exc. to Project Comp.	Set Out & Excavate	NED-1: Contractor's Low Progress	27-Apr-04	29-Apr-04	30-Apr-04	3	0	0	3	30-Apr-04
Info. Release to Project Comp.	No Impact This Window	No Delay This Window	27-Apr-04	27-Apr-04	27-Apr-04	0	0	0	0	

Non-Excusable Delay (NED) · Excusable Delay (ED) · Compensable Delay (CD) · ◆ Contractual Project Completion Milestone

Figure 24 Time Slice Windows Analysis Results for Window 3

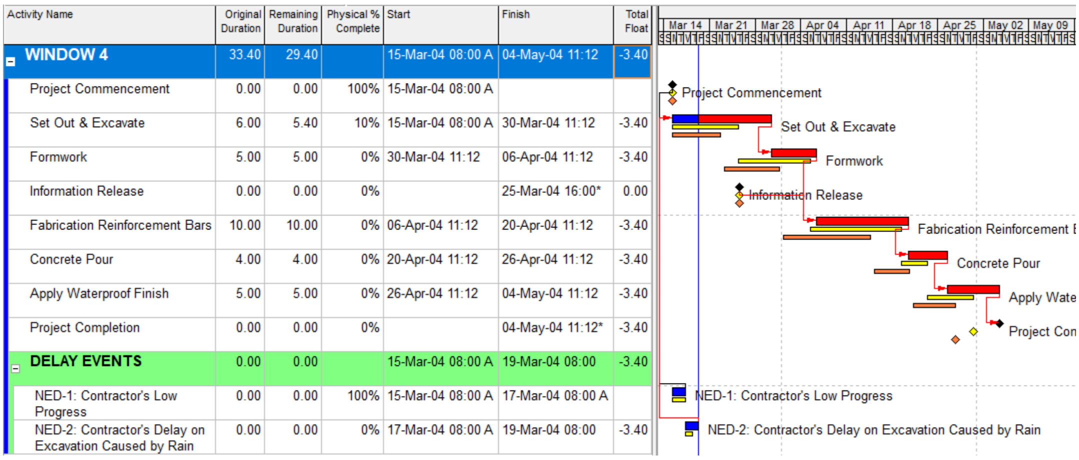
3.2.1.4 Window 4 – From 18 March 2004 08:00 to 19 March 2004 08:00

As also shown in Figure 12, the daily progress records for 18-Mar-04 were as follows:

- No progress was achieved on Set Out & Excavation activity due to rain. The progress of excavation is reported as 10%, which is same as previous window.
- Employer instructed the contractor to not to proceed with Apply Waterproof Finish activity. Employer requested some advice from the Contractor on alternative solutions.

As mentioned before, the Contractor is contractually obliged to take necessary measures to make progress in rainy weather. Thus, this is categorized as a non-excusable delay. The Employer only instructed the Contractor not to proceed with Apply Waterproof Finish; however, no alternative solution was defined for or instructed to the Contractor. Since the complete schedule impact of changing the waterproof solution was not known at this stage, the instruction of not to proceed with Apply Waterproof Finish is not yet reflected in the program.

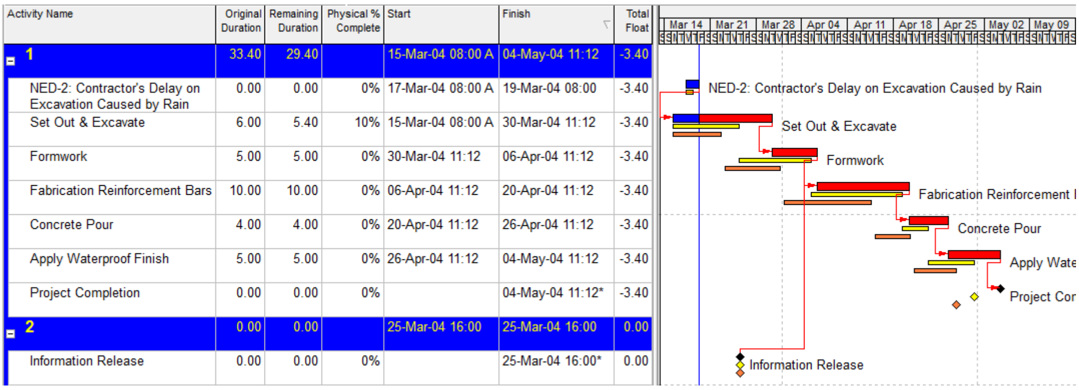
Figure 25 shows the updated program for Window 4. The project completion date is shifted to 04-May-04, which means there is a 4-calendar-day delay compared to the previous window, and a 7-calendar-day delay compared to the as-planned program. Even though the Total Float value of Project Completion activity is calculated as -3.4 days based on working days, the delay to Project Completion milestone is 7 calendar days because 01-May-04, 02-May-04, and 03-May-04 are non-working days. The delay occurred due to stoppage in of the Set Out & Excavation activity caused by rainy weather. Activity related to this non-excusable delay event can be seen in the updated program as NED-2: Contractor’s Delay on Excavation Caused by Rain. The delay event is linked with Set Out & Excavate activity as it impacted the progress of excavation.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 4	33.40	29.40		15-Mar-04 08:00 A	04-May-04 11:12	-3.40
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	5.40	10%	15-Mar-04 08:00 A	30-Mar-04 11:12	-3.40
Formwork	5.00	5.00	0%	30-Mar-04 11:12	06-Apr-04 11:12	-3.40
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00
Fabrication Reinforcement Bars	10.00	10.00	0%	06-Apr-04 11:12	20-Apr-04 11:12	-3.40
Concrete Pour	4.00	4.00	0%	20-Apr-04 11:12	26-Apr-04 11:12	-3.40
Apply Waterproof Finish	5.00	5.00	0%	26-Apr-04 11:12	04-May-04 11:12	-3.40
Project Completion	0.00	0.00	0%		04-May-04 11:12*	-3.40
DELAY EVENTS	0.00	0.00		15-Mar-04 08:00 A	19-Mar-04 08:00	-3.40
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	0%	17-Mar-04 08:00 A	19-Mar-04 08:00	-3.40

Figure 25 Updated Program for Window 4

Figure 26 shows the float paths to Project Completion milestone on the updated program. The delay impacted only Float Path 1, which starts from the activity Set Out & Excavate and completes with Project Completion milestone, because Float Path 2 has 0 days total float. The delay event NED-2: Contractor's Delay on Excavation Caused by Rain also appears in Float Path 1, which shows that it caused a critical delay to completion.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	33.40	29.40		15-Mar-04 08:00 A	04-May-04 11:12	-3.40
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	0%	17-Mar-04 08:00 A	19-Mar-04 08:00	-3.40
Set Out & Excavate	6.00	5.40	10%	15-Mar-04 08:00 A	30-Mar-04 11:12	-3.40
Formwork	5.00	5.00	0%	30-Mar-04 11:12	06-Apr-04 11:12	-3.40
Fabrication Reinforcement Bars	10.00	10.00	0%	06-Apr-04 11:12	20-Apr-04 11:12	-3.40
Concrete Pour	4.00	4.00	0%	20-Apr-04 11:12	26-Apr-04 11:12	-3.40
Apply Waterproof Finish	5.00	5.00	0%	26-Apr-04 11:12	04-May-04 11:12	-3.40
Project Completion	0.00	0.00	0%		04-May-04 11:12*	-3.40
2	0.00	0.00		25-Mar-04 16:00	25-Mar-04 16:00	0.00
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00

Figure 26 Float Paths of Updated Program for Window 4

The results of Window 4 of the delay analysis are shown in a summary format in Figure 27. There is a 7-day non-excusable delay on the Project Completion milestone at the end of this window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 4																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	NED-2: Contr. Delay on Excavat. Caused by Rain	27-Apr-04	30-Apr-04	04-May-04	7	0	0	7	◆								4-May-04								
Info. Release to Project Comp.	No Impact This Window	No Delay This Window	27-Apr-04	27-Apr-04	27-Apr-04	0	0	0	0																	

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 27 Time Slice Windows Analysis Results for Window 4

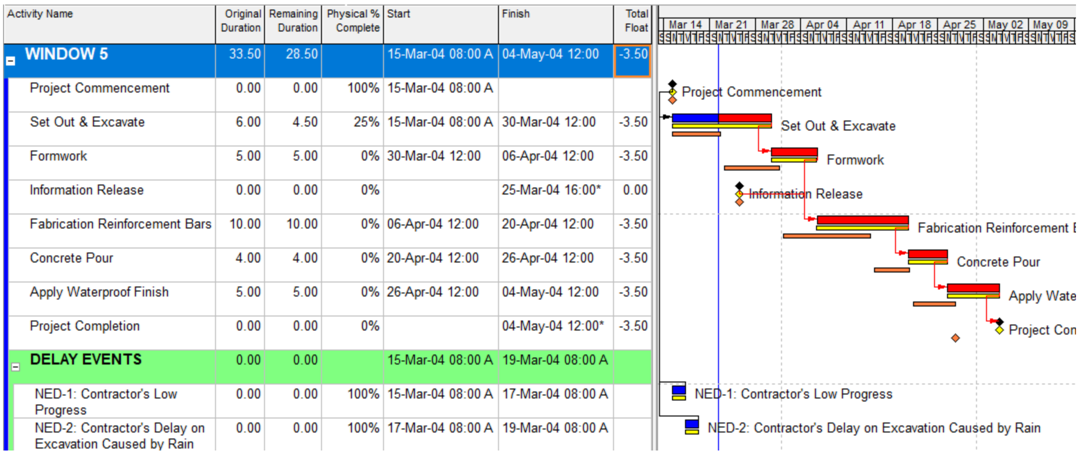
3.2.1.5 Window 5 – From 19 March 2004 08:00 to 22 March 2004 08:00

19-Mar-04 was a working day, and 20-Mar-04 and 21-Mar-04 were non-working days. As also shown in Figure 12, the daily progress records for 19-Mar-04 were as follows:

- The Contractor reported the cumulative percentage of completed of Set Out & Excavate activity as 25%.
- The Contractor provided the Employer with suggestions for waterproofing

Since the cumulative progress of Set Out & Excavation is 25% and planned duration of the activity was 6 days, the estimated remaining duration is updated in the program is 4.5 days. Even though the Contractor provided the Employer some suggestions on waterproofing, instructions for the new waterproofing scope have not yet been received from the Employer. Thus, no revision has been made to the updated program related to Apply Waterproof Finish activity in this window.

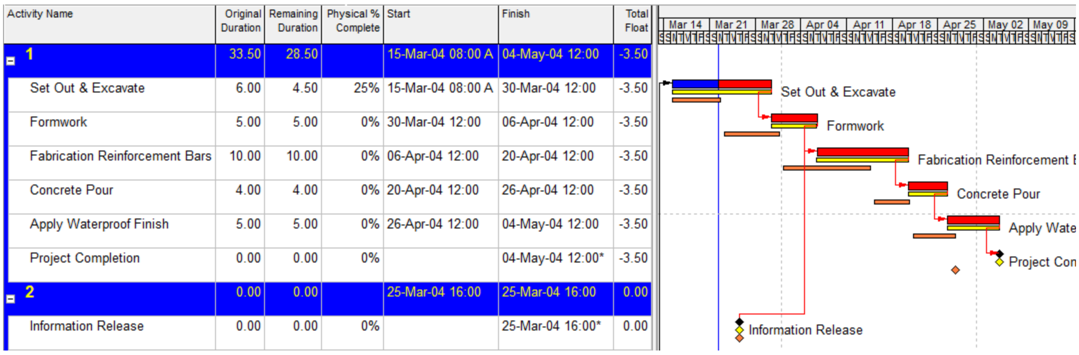
Figure 28 shows the updated program for Window 5. The project completion date is kept as 04-May-04, which means there is no delay compared to the previous window, and there is a 7-calendar-day delay compared to the as-planned program. Even though the total float of project milestone has been reduced from -3.4 days to -3.5 days due to low progress of Contractor, it did not have any impact on the forecasted project completion date. Due to that, no delay event was created in this window.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 5	33.50	28.50		15-Mar-04 08:00 A	04-May-04 12:00	-3.50
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	4.50	25%	15-Mar-04 08:00 A	30-Mar-04 12:00	-3.50
Formwork	5.00	5.00	0%	30-Mar-04 12:00	06-Apr-04 12:00	-3.50
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00
Fabrication Reinforcement Bars	10.00	10.00	0%	06-Apr-04 12:00	20-Apr-04 12:00	-3.50
Concrete Pour	4.00	4.00	0%	20-Apr-04 12:00	26-Apr-04 12:00	-3.50
Apply Waterproof Finish	5.00	5.00	0%	26-Apr-04 12:00	04-May-04 12:00	-3.50
Project Completion	0.00	0.00	0%		04-May-04 12:00*	-3.50
DELAY EVENTS	0.00	0.00		15-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	

Figure 28 Updated Program for Window 5

Figure 29 shows the float paths to Project Completion milestone on the updated program. The delay impacted only Float Path 1, which starts from activity Set Out & Excavate and completes with Project Completion milestone, because Float Path 2 has 0 days of total float.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	33.50	28.50		15-Mar-04 08:00 A	04-May-04 12:00	-3.50
Set Out & Excavate	6.00	4.50	25%	15-Mar-04 08:00 A	30-Mar-04 12:00	-3.50
Formwork	5.00	5.00	0%	30-Mar-04 12:00	06-Apr-04 12:00	-3.50
Fabrication Reinforcement Bars	10.00	10.00	0%	06-Apr-04 12:00	20-Apr-04 12:00	-3.50
Concrete Pour	4.00	4.00	0%	20-Apr-04 12:00	26-Apr-04 12:00	-3.50
Apply Waterproof Finish	5.00	5.00	0%	26-Apr-04 12:00	04-May-04 12:00	-3.50
Project Completion	0.00	0.00	0%		04-May-04 12:00*	-3.50
2	0.00	0.00		25-Mar-04 16:00	25-Mar-04 16:00	0.00
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00

Figure 29 Float Paths of Updated Program for Window 5

The results of Window 5 of the delay analysis are shown in a summary format in Figure 30. There is a 7-day non-excusable delay on the Project Completion milestone at the end of this window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 5

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	No Delay This Window	27-Apr-04	04-May-04	04-May-04	7	0	0	7									4-May-04								
Info. Release to Project Comp.	No Impact This Window	No Delay This Window	27-Apr-04	27-Apr-04	27-Apr-04	0	0	0	0																	

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 30 Time Slice Windows Analysis Results for Window 5

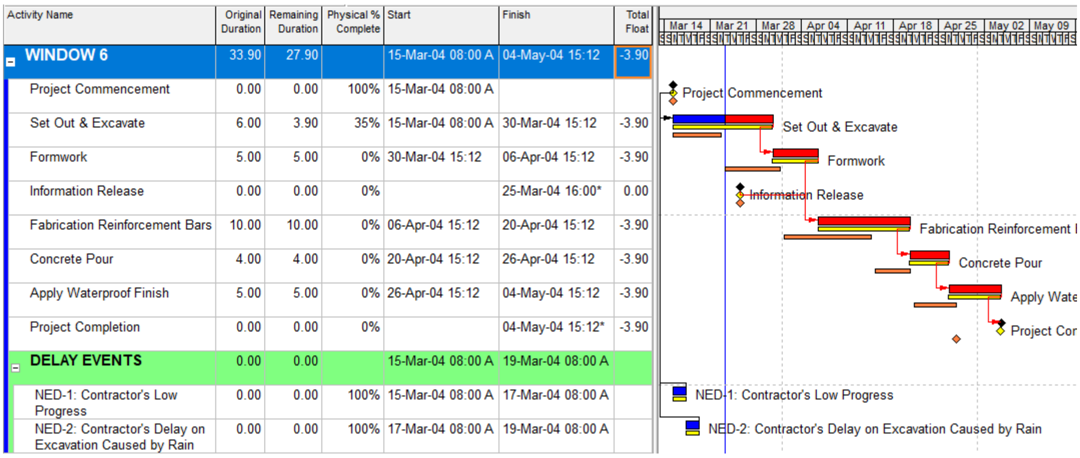
3.2.1.6 Window 6 – From 22 March 2004 08:00 to 23 March 2004 08:00

As also shown in Figure 12, the daily progress records for 22-Mar-04 were as follows:

- The Contractor reported the cumulative percentage of completed Set Out & Excavate activity as 35%.
- Employer considered using Admix in the Concrete instead of waterproof finish and requested the test data for Admix from the Contractor.

Since the cumulative progress of Set Out & Excavation is 35% and the planned duration of the activity was 6 days, the earned duration of the activity is 2.1 days. Hence, the estimated remaining duration is updated in the program as 3.9 days. Instruction of new waterproofing scope had not yet been received from the Employer. Due to that, there was no revision on the updated program related to Apply Waterproof Finish activity in this window.

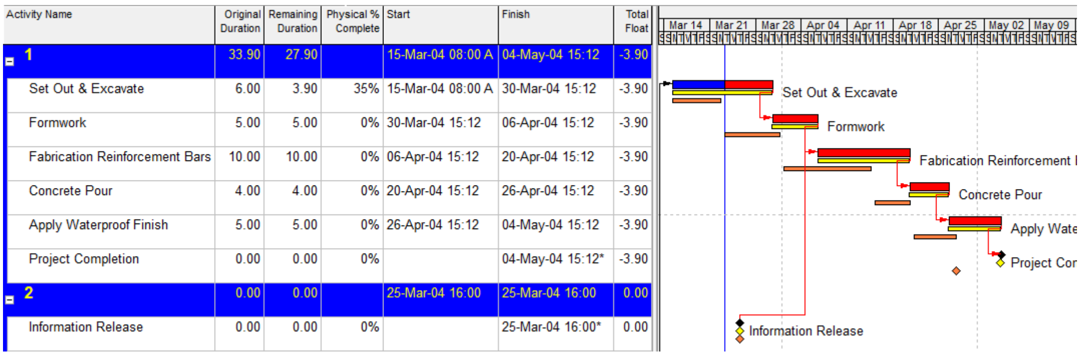
Figure 31 shows the updated program for Window 6. The project completion date is kept as 04-May-04, which means there is no delay compared to the previous window, and a delay of 7 calendar days compared to the as-planned program. Even though the total float of project milestone is reduced from -3.5 days to -3.9 days due to low progress of Contractor, it does not have any impact on the forecasted project completion date. Therefore, no delay event is created in this window.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 6	33.90	27.90		15-Mar-04 08:00 A	04-May-04 15:12	-3.90
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	3.90	35%	15-Mar-04 08:00 A	30-Mar-04 15:12	-3.90
Formwork	5.00	5.00	0%	30-Mar-04 15:12	06-Apr-04 15:12	-3.90
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00
Fabrication Reinforcement Bars	10.00	10.00	0%	06-Apr-04 15:12	20-Apr-04 15:12	-3.90
Concrete Pour	4.00	4.00	0%	20-Apr-04 15:12	26-Apr-04 15:12	-3.90
Apply Waterproof Finish	5.00	5.00	0%	26-Apr-04 15:12	04-May-04 15:12	-3.90
Project Completion	0.00	0.00	0%		04-May-04 15:12*	-3.90
DELAY EVENTS	0.00	0.00		15-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	

Figure 31 Updated Program for Window 6

Figure 32 shows the float paths to Project Completion milestone on the updated program. The delay impacted only the Float Path 1, which starts from activity Set Out & Excavate and completes with Project Completion milestone, because Float Path 2 has 0 days of total float.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	33.90	27.90		15-Mar-04 08:00 A	04-May-04 15:12	-3.90
Set Out & Excavate	6.00	3.90	35%	15-Mar-04 08:00 A	30-Mar-04 15:12	-3.90
Formwork	5.00	5.00	0%	30-Mar-04 15:12	06-Apr-04 15:12	-3.90
Fabrication Reinforcement Bars	10.00	10.00	0%	06-Apr-04 15:12	20-Apr-04 15:12	-3.90
Concrete Pour	4.00	4.00	0%	20-Apr-04 15:12	26-Apr-04 15:12	-3.90
Apply Waterproof Finish	5.00	5.00	0%	26-Apr-04 15:12	04-May-04 15:12	-3.90
Project Completion	0.00	0.00	0%		04-May-04 15:12*	-3.90
2	0.00	0.00		25-Mar-04 16:00	25-Mar-04 16:00	0.00
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00

Figure 32 Float Paths of Updated Program for Window 6

The results of Window 6 of the delay analysis are shown in a summary format in Figure 33. There is 7-day non-excusable delay on the Project Completion milestone at the end of this window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 6																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	No Delay This Window	27-Apr-04	04-May-04	04-May-04	7	0	0	7								4-May-04									
Info. Release to Project Comp.	No Impact This Window	No Delay This Window	27-Apr-04	27-Apr-04	27-Apr-04	0	0	0	0																	

Non-Excusable Delay (NED) — Excusable Delay (ED) — Compensable Delay (CD) — ◆ Contractual Project Completion Milestone

Figure 33 Time Slice Windows Analysis Results for Window 6

3.2.1.7 Window 7 – From 23 March 2004 08:00 to 24 March 2004 08:00

As also shown in Figure 12, the daily progress records for 23-Mar-04 were as follows:

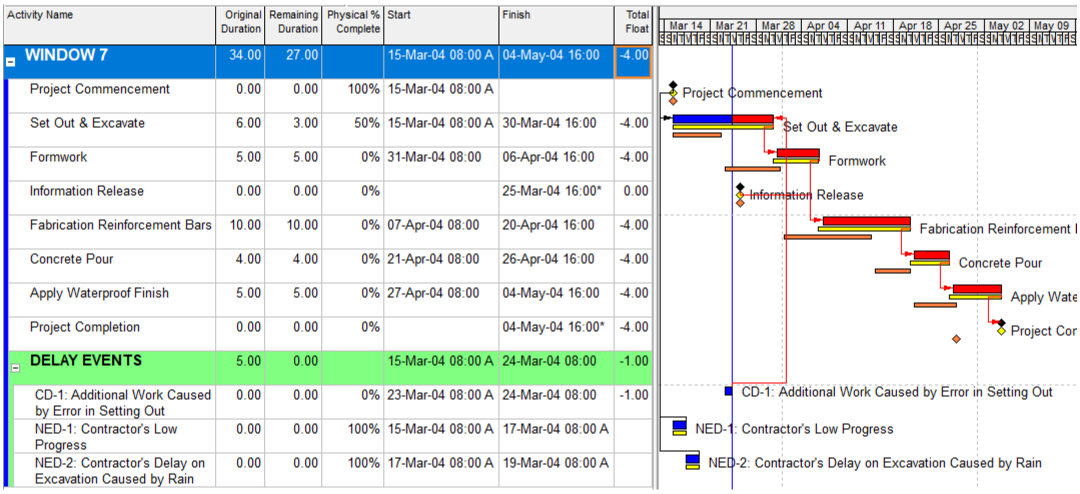
- Contractor reported the cumulative percentage of completed Set Out & Excavate activity as 50%. Good progress was maintained despite rainy weather.
- Contractor reported that Employer has said setting out was mistaken and the excavation has been done for an additional bay.

Since the cumulative progress of Set Out & Excavation is 50% and planned duration of the activity was 6 days, the earned duration of the activity is 3 days. Hence, the estimated remaining duration of the activity is updated in the program as 3 days.

According to the Contract Document, errors or ambiguities in description of the work is an Employer's risk. The slab drawing provided by the Employer was used by the Contractor for setting out showed an additional bay that led to unnecessary excavation. Therefore, the delay caused by this event is considered an Employer

Delay. Hence, the delay type is compensable delay that results in entitlement to both extension of time and the associated prolongation costs.

Figure 34 shows the updated program for Window 7. The project completion date is kept as 04-May-04, which means there is no delay compared to the previous window, and a delay of 7 calendar days compared to the as-planned program. A delay event activity is created in the updated program to monitor the impact of additional work due to an error in the setting out of the excavation. The activity representing the delay event named as CD-1: Additional Work Caused by Error in Setting Out is linked with Set Out & Excavate activity with a finish-to-finish relationship because excavation cannot be considered as completed and Formwork cannot be started without completion of the additional work caused by error in setting out.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 7	34.00	27.00		15-Mar-04 08:00 A	04-May-04 16:00	-4.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	3.00	50%	15-Mar-04 08:00 A	30-Mar-04 16:00	-4.00
Formwork	5.00	5.00	0%	31-Mar-04 08:00	06-Apr-04 16:00	-4.00
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00
Fabrication Reinforcement Bars	10.00	10.00	0%	07-Apr-04 08:00	20-Apr-04 16:00	-4.00
Concrete Pour	4.00	4.00	0%	21-Apr-04 08:00	26-Apr-04 16:00	-4.00
Apply Waterproof Finish	5.00	5.00	0%	27-Apr-04 08:00	04-May-04 16:00	-4.00
Project Completion	0.00	0.00	0%		04-May-04 16:00*	-4.00
DELAY EVENTS	5.00	0.00		15-Mar-04 08:00 A	24-Mar-04 08:00	-1.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	24-Mar-04 08:00	-1.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	

Figure 34 Updated Program for Window 7

Figure 35 shows the float paths to Project Completion milestone on the updated program. Float Path 1 was not changed in this update and the delays that occurred on this path had an impact on the Project Completion milestone by 7 calendar days. However, Float Path: 2, which contains the created delay event of CD-1: Additional Work Caused by Error in Setting Out, also delayed the project with a concurrent effect. Since the total float of the delay event is -1 days, it has an impact on the project completion by 1 working day, which pushes the project completion date to 28-Apr-04.

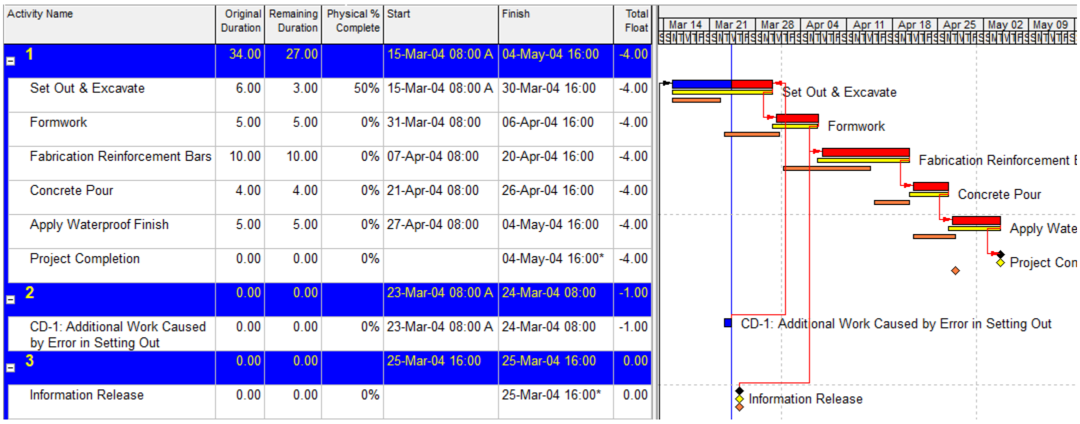


Figure 35 Float Paths of Updated Program for Window 7

The results of Window 7 of the delay analysis are shown in a summary format in Figure 36. In the path from Set Out & Excavate to Project Completion, there is a 7-calendar-day non-excusable delay coming from Float Path 1. There is also a 1-day compensable delay in the same path coming from Float Path 2. Due to that, there is a concurrent effect of a 1-day non-excusable delay and compensable delay on the Project Completion milestone. Whenever a non-excusable delay and compensable delay have a concurrent effect, the delay is considered to be an excusable delay, which gives entitlement to extension of time but no entitlement to prolongation costs.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 7

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	CD-1: Add. Work Caused by Error in Setting	27-Apr-04	04-May-04	04-May-04	7	0	1	6	◆	28-Apr-04						4-May-04									
Info. Release to Project Comp.	No Impact This Window	No Delay This Window	27-Apr-04	27-Apr-04	27-Apr-04	0	0	0	0																	

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 36 Time Slice Windows Analysis Results for Window 7

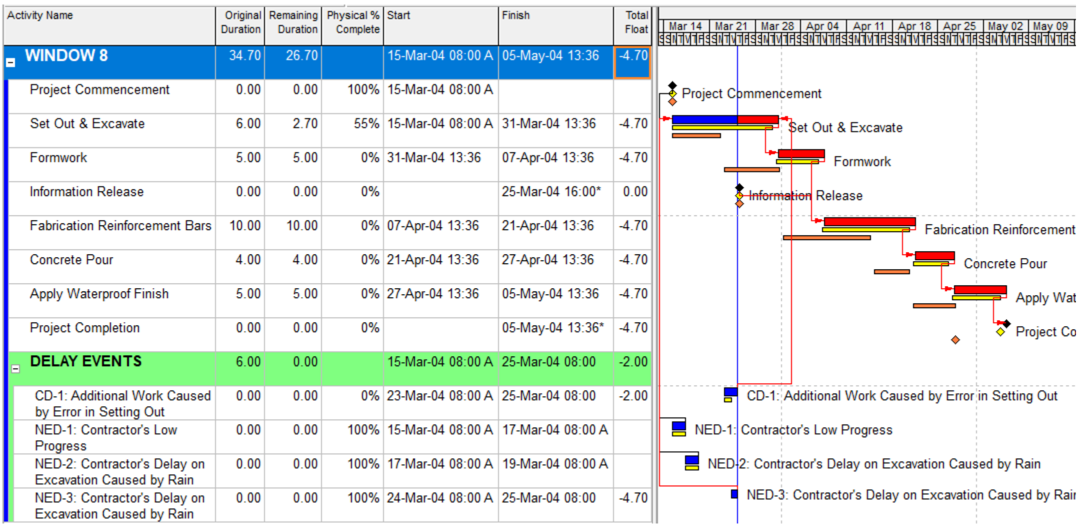
3.2.1.8 Window 8 – From 24 March 2004 08:00 to 25 March 2004 08:00

As also shown in Figure 12, the daily progress records for 24-Mar-04 were as follows:

- The Contractor reported that Set Out & Excavate activity progress is hampered due to heavy rain and water had to be pumped from excavation. The cumulative percentage of completed activity is reported as 55%.
- The Contractor reported that the effect of the setting out problem is still ongoing.

Since the cumulative progress of Set Out & Excavation is 55% and the planned duration of the activity was 6 days, the earned duration of the activity is calculated as 3.3 days. Thus, the estimated remaining duration is updated in the program as 2.7 days. As previously discussed, maintaining progress under rainy weather conditions is the contractual responsibility of the Contractor. This makes the delay attributable to the Contractor and is therefore a non-excusable delay.

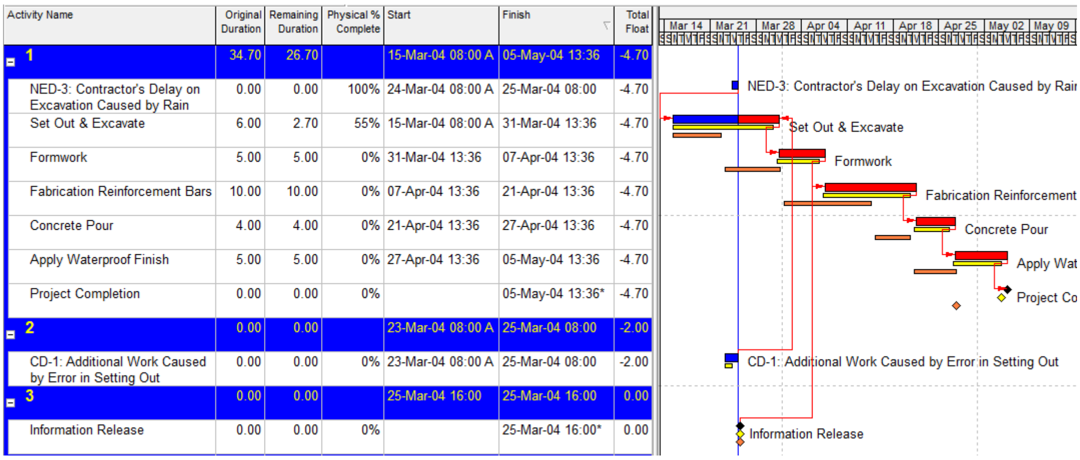
Figure 37 shows the updated program for Window 8. The project completion date is shifted to 05-May-04, which means there is a delay of 1 calendar day compared to the previous window, and a delay of 8 calendar days compared to the as-planned program. The critical delay occurred due to low progress of the Set Out & Excavate activity caused by rainy weather. Activity related to this non-excusable delay event can be seen in the updated program as NED-3: Contractor’s Delay on Excavation Caused by Rain. The delay event is linked with the Set Out & Excavate activity, as it impacted the progress of excavation.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 8	34.70	26.70		15-Mar-04 08:00 A	05-May-04 13:36	-4.70
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	2.70	55%	15-Mar-04 08:00 A	31-Mar-04 13:36	-4.70
Formwork	5.00	5.00	0%	31-Mar-04 13:36	07-Apr-04 13:36	-4.70
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00
Fabrication Reinforcement Bars	10.00	10.00	0%	07-Apr-04 13:36	21-Apr-04 13:36	-4.70
Concrete Pour	4.00	4.00	0%	21-Apr-04 13:36	27-Apr-04 13:36	-4.70
Apply Waterproof Finish	5.00	5.00	0%	27-Apr-04 13:36	05-May-04 13:36	-4.70
Project Completion	0.00	0.00	0%		05-May-04 13:36*	-4.70
DELAY EVENTS	6.00	0.00		15-Mar-04 08:00 A	25-Mar-04 08:00	-2.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	25-Mar-04 08:00	-2.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	25-Mar-04 08:00	-4.70

Figure 37 Updated Program for Window 8

Figure 38 shows the float paths to Project Completion milestone on the updated program. Float Path 1, which contains NED-3: Contractor's Delay on Excavation Caused by Rain, delays the project completion milestone date to 05-May-04, which means an 8-calendar-day delay compared to the as-planned program. In addition to that, Float Path 2, which contains the created delay event of CD-1: Additional Work Caused by Error in Setting Out, delays the project with a concurrent effect. Since the total float of the delay event is -2 days, it has a 2 working day impact on the schedule.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	34.70	26.70		15-Mar-04 08:00 A	05-May-04 13:36	-4.70
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	25-Mar-04 08:00	-4.70
Set Out & Excavate	6.00	2.70	55%	15-Mar-04 08:00 A	31-Mar-04 13:36	-4.70
Formwork	5.00	5.00	0%	31-Mar-04 13:36	07-Apr-04 13:36	-4.70
Fabrication Reinforcement Bars	10.00	10.00	0%	07-Apr-04 13:36	21-Apr-04 13:36	-4.70
Concrete Pour	4.00	4.00	0%	21-Apr-04 13:36	27-Apr-04 13:36	-4.70
Apply Waterproof Finish	5.00	5.00	0%	27-Apr-04 13:36	05-May-04 13:36	-4.70
Project Completion	0.00	0.00	0%		05-May-04 13:36*	-4.70
2	0.00	0.00		23-Mar-04 08:00 A	25-Mar-04 08:00	-2.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	25-Mar-04 08:00	-2.00
3	0.00	0.00		25-Mar-04 16:00	25-Mar-04 16:00	0.00
Information Release	0.00	0.00	0%		25-Mar-04 16:00*	0.00

Figure 38 Float Paths of Updated Program for Window 8

The results of Window 8 of the delay analysis are shown in a summary format in Figure 39. In the path from Set Out & Excavate to Project Completion, there is an 8-calendar-day non-excusable delay coming from Float Path 1 caused by delay event NED-3: Contractor's Delay on Excavation Caused by Rain. There is also a compensable delay of 2 calendar days in the same path which is coming from Float Path 2, caused by delay event CD-1: Additional Work Caused by Error in Setting Out. Due to that, there is a concurrent effect of a 2-calendar-day non-excusable delay and compensable delay on the Project Completion milestone. Whenever non-excusable delay and compensable delay have a concurrent effect, the is considered to be an excusable delay, which gives entitlement to extension of time but not to prolongation costs.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 8																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	NED-3: Contr. Delay Exc. CD-1: Error in Setting	27-Apr-04	04-May-04	05-May-04	8	0	2	6	◆		29-Apr-04							05-May-04							
Info. Release to Project Comp.	No Impact This Window	No Delay This Window	27-Apr-04	27-Apr-04	27-Apr-04	0	0	0	0																	

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 39 Time Slice Windows Analysis Results for Window 8

3.2.1.9 Window 9 – From 25 March 2004 08:00 to 30 March 2004 08:00

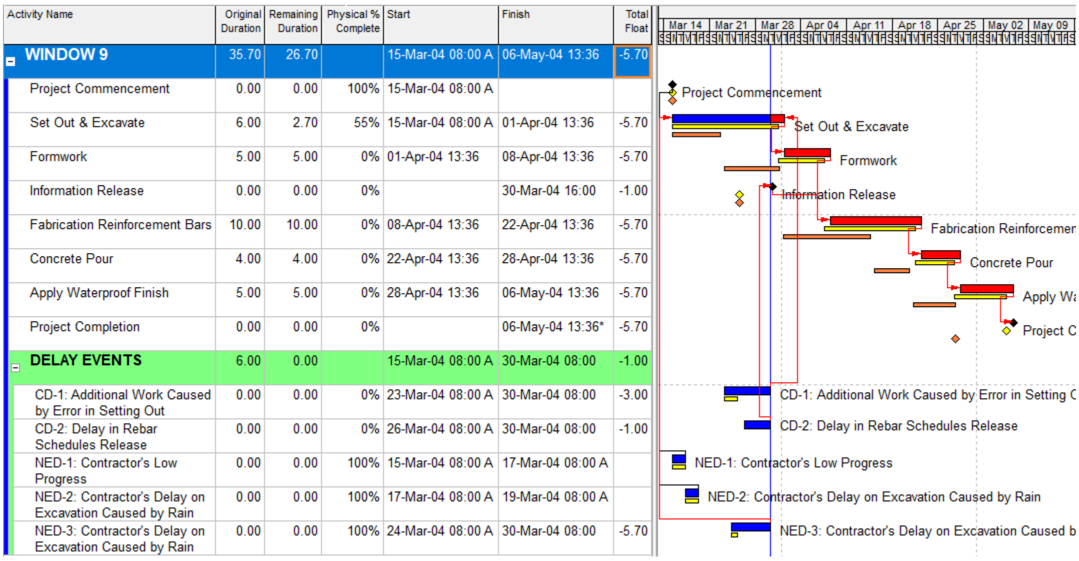
25-Mar-04 was a working day, and 26-Mar-04, 27-Mar-04, 28-Mar-04 and 29-Mar-04 were non-working days. As also shown in Figure 12, the daily progress records for 25-Mar-04 were as follows:

- The Contractor reported that Set Out & Excavate activity progress has been stopped due to heavy rain water having to be pumped from the excavation. The cumulative percentage of completed activity is reported as 55%.

- The Contractor reported that correction measures for the setting out problem were being continued.
- The Contractor had continued pumping the water out of the excavation during non-working days.
- Information Release activity, which falls under the responsibility of the Employer and is related to the release of rebar schedules, has been delayed. According to the as-planned schedule, the Information Release should have been done 25-Mar-04.

Since the cumulative progress of Set Out & Excavate is 55% and the planned duration of the activity was 6 days, the earned duration of the activity is 3.3 days. Hence, the estimated remaining duration is updated in the program as 2.7 days. As previously discussed, maintaining progress under rainy weather conditions is the contractual responsibility of the Contractor. Thus, the delay is attributable to the Contractor and is categorized as a non-excusable delay. According to the Contract Document, failure to supply information drawings or details in due time is at the Employer's Risk. Due to that, delay on activity of Information Release is defined as Employer's delay and the type of the delay is compensable delay.

Figure 40 shows the updated program for Window 9. The project completion date is shifted to 06-May-04, which means there is a 1-calendar-day delay compared to the previous window and a delay of 9 calendar days compared to the as-planned program. The critical delay occurred due to stoppage in Set Out & Excavate activity caused by heavy rain. Furthermore, a delay event activity is created for Employer's delay on Information Release activity as CD-2: Delay in Rebar Schedules Release and is linked with Information Release activity to be seen in the correct float path to analyze the impact of the delay on project completion milestone. The relationship between CD-2: Delay in Rebar Schedules Release delay event and Information Release activity is created as finish to start plus one day lag to reflect the delay accurately on Information Release activity which is a milestone.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 9	35.70	26.70		15-Mar-04 08:00 A	06-May-04 13:36	-5.70
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	2.70	55%	15-Mar-04 08:00 A	01-Apr-04 13:36	-5.70
Formwork	5.00	5.00	0%	01-Apr-04 13:36	08-Apr-04 13:36	-5.70
Information Release	0.00	0.00	0%		30-Mar-04 16:00	-1.00
Fabrication Reinforcement Bars	10.00	10.00	0%	08-Apr-04 13:36	22-Apr-04 13:36	-5.70
Concrete Pour	4.00	4.00	0%	22-Apr-04 13:36	28-Apr-04 13:36	-5.70
Apply Waterproof Finish	5.00	5.00	0%	28-Apr-04 13:36	06-May-04 13:36	-5.70
Project Completion	0.00	0.00	0%		06-May-04 13:36*	-5.70
DELAY EVENTS	6.00	0.00		15-Mar-04 08:00 A	30-Mar-04 08:00	-1.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	30-Mar-04 08:00	-3.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	30-Mar-04 08:00	-1.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00	-5.70

Figure 40 Updated Program for Window 9

Figure 41 shows the float paths to Project Completion milestone on the updated program. Float Path 1, which contains NED-3: Contractor's Delay on Excavation Caused by Rain, delays the project completion milestone date to 06-May-04 which means a 9-calendar-day delay compared to the as-planned program. In addition to that, Float Path 2, which contains delay event of CD-1: Additional Work Caused by Error in Setting Out, also delays the project with a concurrent effect. Since the total float of the delay event is -3 days, it has a schedule impact of 3 working days, which pushes the project completion date to 30-Apr-04. Furthermore, Float Path 3, which contains the delay event of CD-2: Delay in Rebar Schedules Release, also delays the project with a concurrent effect. Since the total float of the delay event is -1 days, it has a schedule impact of 1 working day, which pushes the project completion date to 28-Apr-04.

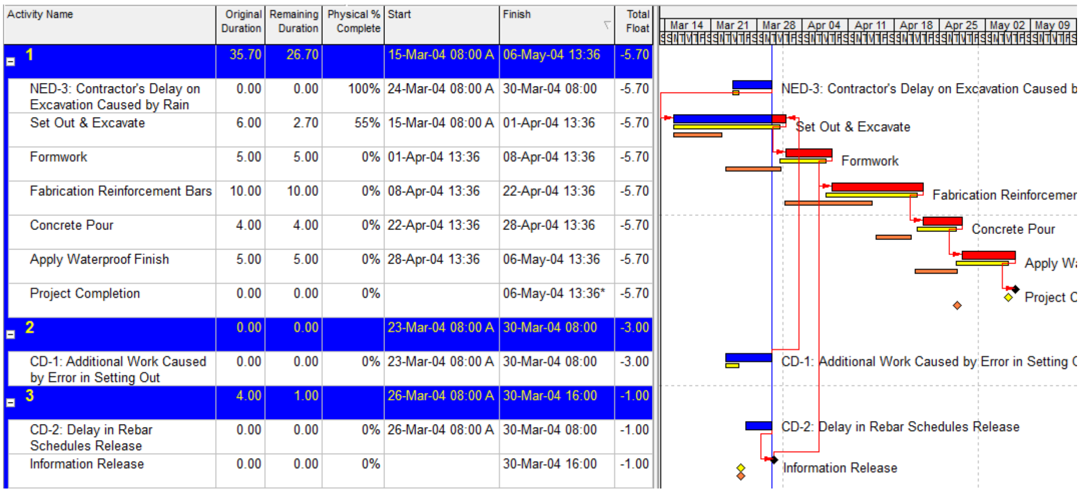


Figure 41 Float Paths of Updated Program for Window 9

The results of Window 9 of the delay analysis are shown in a summary format in Figure 42. In the path from Set Out & Excavate to Project Completion, there is a 9-calendar-day non-excusable delay coming from Float Path 1 that is caused by delay event NED-3: Contractor's Delay on Excavation Caused by Rain. Moreover, there is also a 3-calendar-day compensable delay in the same path, which is coming from Float Path 2, caused by delay event CD-1: Additional Work Caused by Error in Setting Out. Due to that, there is a concurrent effect of a 3-calendar-day non-excusable delay and a compensable delay on the Project Completion milestone. Whenever a non-excusable delay and a compensable delay have a concurrent effect, the delay is considered an excusable delay, which gives entitlement to extension of time but not to prolongation costs. Furthermore, in the path from Information Release to Project Completion, there is a 1-calendar-day compensable delay which is coming from Float Path 3, which is caused by delay event CD-2: Delay in Rebar Schedules Release.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 9																												
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	NED-3: Contr. Delay Exc. CD-1: Error in Setting	27-Apr-04	05-May-04	06-May-04	9	0	3	6				30-Apr-04						06-May-04							
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	27-Apr-04	28-Apr-04	1	1	0	0		28-Apr-04															

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 42 Time Slice Windows Analysis Results for Window 9

3.2.1.10 Window 10 – From 30 March 2004 08:00 to 31 March 2004 08:00

As also shown in Figure 12, the daily progress records for 30-Mar-04 were as follows:

- Excavations collapsed due to pump failure. The cumulative percentage of completed Set Out & Excavate activity dropped from 55% to 40% due to collapsed excavations.
- Additional work caused by the setting out error was continued. Excavation is recommenced in the new area.
- Rebar schedules are still not released by the Employer.

The cumulative progress of Set Out & Excavate dropped to 40% and consequently the earned duration of the activity dropped to 2.4 days. Hence, the estimated remaining duration of the activity is updated in the program as 3.6 days. According to the Contract Document, supplying labor, a plant, and materials falls under the responsibility of the Contractor. Furthermore, maintenance of the plants such as pumps also falls within the Contractor’s scope of work. Therefore, the delay caused by pump failure is attributable to the Contractor and the delay type is non-excusable delay.

Figure 43 shows the updated program for Window 10. The project completion date is shifted to 10-May-04, which means there is a 4-calendar-day delay compared to the previous window and a 13-calendar-day delay compared to the as-planned program. The critical delay occurred due to the collapsed excavation that affected the Set Out & Excavate activity. An activity representing this non-excusable delay event is created as NED-4: Rework Caused by Collapsed Excavation and is linked with Set Out & Excavate activity to show the cause-and-effect relationship in the updated program. Furthermore, the effect of delay events CD-1: Additional Work Caused by Error in Setting Out and CD-2: Delay in Rebar Schedules Release continues.

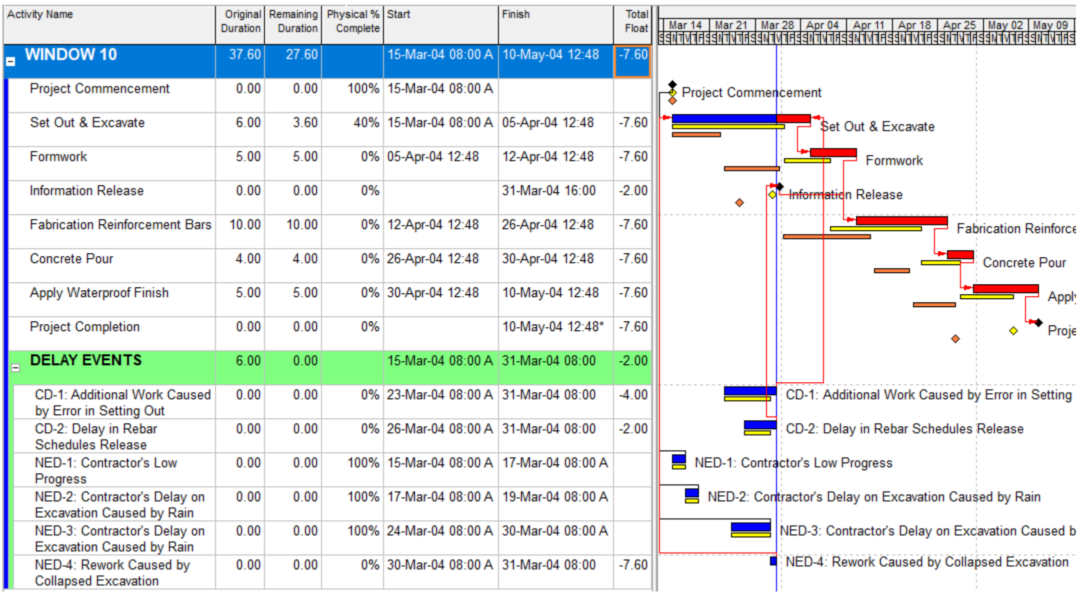
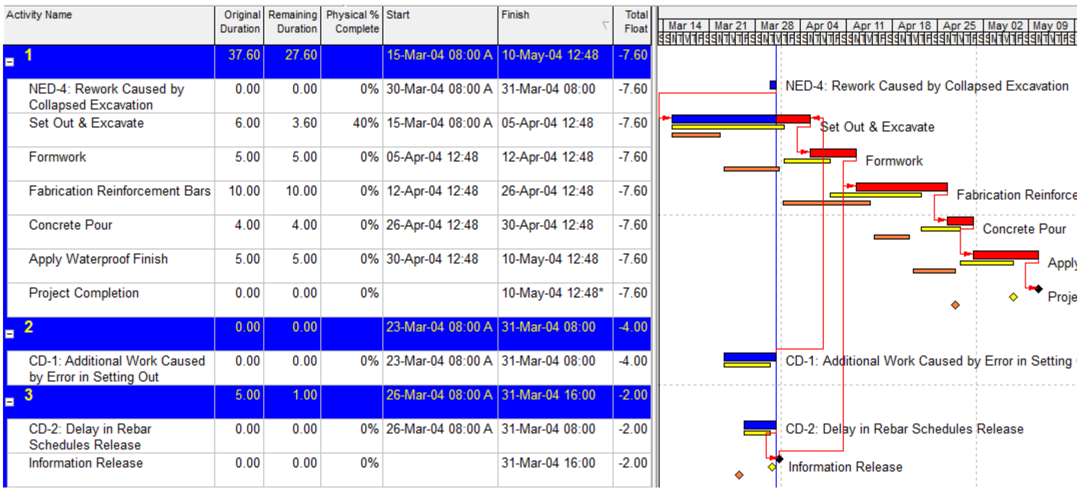


Figure 43 Updated Program for Window 10

Figure 44 shows the float paths to Project Completion milestone on the updated program. Float Path 1, which contains NED-4: Rework Caused by Collapsed Excavation, delays the Project Completion milestone date to 10-May-04, which means a 13-calendar-day delay compared to the as-planned program. In addition to that, Float Path 2, which contains delay event of CD-1: Additional Work Caused by Error in Setting Out, also delays the project with a concurrent effect. Since the total float of the delay event is -4 days, it has a schedule impact of 4 working days, which pushes the project completion date to 04-May-04. Furthermore, Float Path 3, which contains the delay event of CD-2: Delay in Rebar Schedules Release, also delays the project with a concurrent effect. Since the total float of the delay event is -2 days, it has a schedule impact of 2 working days, which pushes the project completion date to 29-Apr-04.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	37.60	27.60		15-Mar-04 08:00 A	10-May-04 12:48	-7.60
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	0%	30-Mar-04 08:00 A	31-Mar-04 08:00	-7.60
Set Out & Excavate	6.00	3.60	40%	15-Mar-04 08:00 A	05-Apr-04 12:48	-7.60
Formwork	5.00	5.00	0%	05-Apr-04 12:48	12-Apr-04 12:48	-7.60
Fabrication Reinforcement Bars	10.00	10.00	0%	12-Apr-04 12:48	26-Apr-04 12:48	-7.60
Concrete Pour	4.00	4.00	0%	26-Apr-04 12:48	30-Apr-04 12:48	-7.60
Apply Waterproof Finish	5.00	5.00	0%	30-Apr-04 12:48	10-May-04 12:48	-7.60
Project Completion	0.00	0.00	0%		10-May-04 12:48*	-7.60
2	0.00	0.00		23-Mar-04 08:00 A	31-Mar-04 08:00	-4.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	31-Mar-04 08:00	-4.00
3	5.00	1.00		26-Mar-04 08:00 A	31-Mar-04 16:00	-2.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	31-Mar-04 08:00	-2.00
Information Release	0.00	0.00	0%		31-Mar-04 16:00	-2.00

Figure 44 Float Paths of Updated Program for Window 10

The results of Window 10 of the delay analysis are shown in a summary format in Figure 45. In the path from Set Out & Excavate to Project Completion, there is 13-calendar-day non-excusable delay which is coming from Float Path 1 caused by delay event NED-4: Rework Caused by Collapsed Excavation. In addition to that, there is also a 7-calendar -day compensable delay in the same path which is coming from Float Path 2 caused by delay event CD-1: Additional Work Caused by Error in Setting Out. Thus, there is concurrent effect of a 7-calendar-day non-excusable delay and compensable delay on the Project Completion milestone. Whenever non-excusable delay and compensable delay have a concurrent effect, the delay is categorized as an excusable delay, which gives entitlement to extension of time but not to prolongation costs. Furthermore, in the path from Information Release to Project Completion, there is a 2-calendar-day compensable delay which is coming from Float Path 3 caused by delay event CD-2: Delay in Rebar Schedules Release.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 10																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	NED-4: Collapsed Excav. CD-1: Error in Setting	27-Apr-04	06-May-04	10-May-04	13	0	7	6								04-May-04						10-May-04			
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	28-Apr-04	29-Apr-04	2	2	0	0				29-Apr-04													

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 45 Time Slice Windows Analysis Results for Window 10

3.2.1.11 Window 11 – From 31 March 2004 08:00 to 01 April 2004 08:00

As also shown in Figure 12, the daily progress records for 31-Mar-04 were as follows:

- Pumping and clearing of collapsed excavation were continued. The cumulative percentage of completed Set Out & Excavate activity is still reported as 40%, as excavation work was not yet restarted.
- Additional work caused by the setting out error was continued.
- Rebar schedules are still not released by the Employer.

The cumulative progress of Set Out & Excavate is still 40% and consequently the earned duration of the activity is 2.4 days. Hence, the estimated remaining duration of the activity is updated in the program as 3.6 days. All the delay events, which were effective in the previous window are still affective in this window.

Figure 46 shows the updated program for Window 11. The project completion date is shifted to 11-May-04, which means there is 1-calendar-day delay compared to the previous window and a 14-calendar-day delay compared to the as-planned program. The critical delay occurred due to non-excusable delay event NED-4: Rework Caused by Collapsed Excavation that affected the Set Out & Excavate activity. Furthermore, the effect of delay events, CD-1: Additional Work Caused by Error in Setting Out and CD-2: Delay in Rebar Schedules Release, which caused concurrent delay to project completion are continued.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 11	38.60	27.60		15-Mar-04 08:00 A	11-May-04 12:48	-8.60
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	3.60	40%	15-Mar-04 08:00 A	06-Apr-04 12:48	-8.60
Formwork	5.00	5.00	0%	06-Apr-04 12:48	13-Apr-04 12:48	-8.60
Information Release	0.00	0.00	0%		01-Apr-04 16:00	-3.00
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 12:48	27-Apr-04 12:48	-8.60
Concrete Pour	4.00	4.00	0%	27-Apr-04 12:48	04-May-04 12:48	-8.60
Apply Waterproof Finish	5.00	5.00	0%	04-May-04 12:48	11-May-04 12:48	-8.60
Project Completion	0.00	0.00	0%		11-May-04 12:48*	-8.60
DELAY EVENTS	6.00	0.00		15-Mar-04 08:00 A	01-Apr-04 08:00	-3.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	01-Apr-04 08:00	-5.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	01-Apr-04 08:00	-3.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	0%	30-Mar-04 08:00 A	01-Apr-04 08:00	-8.60

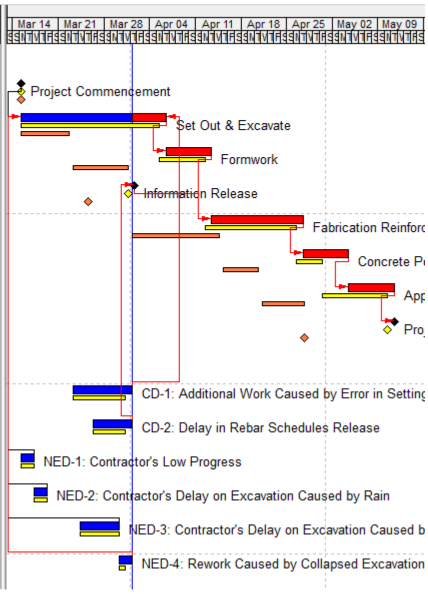
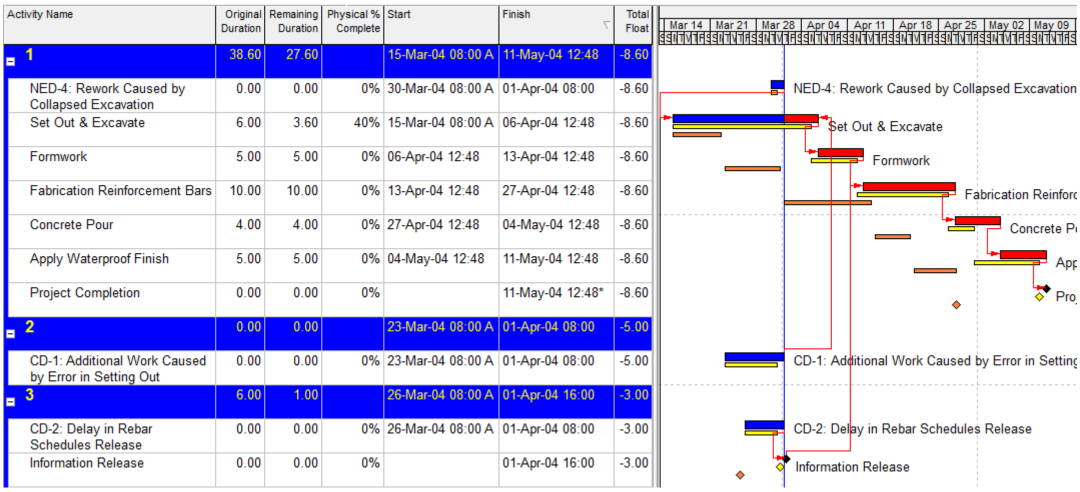


Figure 46 Updated Program for Window 11

Figure 47 shows the float paths to Project Completion milestone on the updated program Float Path 1, which contains NED-4: Rework Caused by Collapsed Excavation, delays the project completion milestone date to 11-May-04, which means a delay of 14 calendar days compared to the as-planned program. In addition, Float Path 2, which contains delay event of CD-1: Additional Work Caused by Error in Setting Out, also delayed the project with a concurrent effect. Since the total float of the delay event is -5 days, it has a 5-working-day schedule impact, which pushes the project completion date to 05-May-04. Furthermore, Float Path 3, which contains delay event of CD-2: Delay in Rebar Schedules Release, also delayed the project with a concurrent effect. Since the total float of the delay event is -3 days, it has a 3-working-day schedule impact, which pushes the project completion date to 30-Apr-04.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	38.60	27.60		15-Mar-04 08:00 A	11-May-04 12:48	-8.60
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	0%	30-Mar-04 08:00 A	01-Apr-04 08:00	-8.60
Set Out & Excavate	6.00	3.60	40%	15-Mar-04 08:00 A	06-Apr-04 12:48	-8.60
Formwork	5.00	5.00	0%	06-Apr-04 12:48	13-Apr-04 12:48	-8.60
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 12:48	27-Apr-04 12:48	-8.60
Concrete Pour	4.00	4.00	0%	27-Apr-04 12:48	04-May-04 12:48	-8.60
Apply Waterproof Finish	5.00	5.00	0%	04-May-04 12:48	11-May-04 12:48	-8.60
Project Completion	0.00	0.00	0%		11-May-04 12:48*	-8.60
2	0.00	0.00		23-Mar-04 08:00 A	01-Apr-04 08:00	-5.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	01-Apr-04 08:00	-5.00
3	6.00	1.00		26-Mar-04 08:00 A	01-Apr-04 16:00	-3.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	01-Apr-04 08:00	-3.00
Information Release	0.00	0.00	0%		01-Apr-04 16:00	-3.00

Figure 47 Float Paths of Updated Program for Window 11

The results of Window 11 of the delay analysis are shown in a summary format in Figure 48. In the path from Set Out & Excavate to Project Completion, there is a 14-calendar-day non-excusable delay coming from Float Path 1 caused by delay event NED-4: Rework Caused by Collapsed Excavation. There is also an 8-calendar-day compensable delay in the same path coming from Float Path 2 caused by delay event CD-1: Additional Work Caused by Error in Setting Out. Thus, there is a concurrent effect of an 8-calendar-day non-excusable delay and compensable delay on the Project Completion milestone. Whenever non-excusable delay and compensable delay have a concurrent effect, the delay is categorized as an excusable delay. Furthermore, in the path from Information Release to Project Completion, there is a 3-calendar-day compensable delay coming from Float Path 3 caused by delay event CD-2: Delay in Rebar Schedules Release.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 11																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	NED-4: Collapsed Excav. CD-1: Error in Setting	27-Apr-04	10-May-04	11-May-04	14	0	8	6	◆								05-May-04						11-May-04		
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	29-Apr-04	30-Apr-04	3	3	0	0	◆			30-Apr-04													

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 48 Time Slice Windows Analysis Results for Window 11

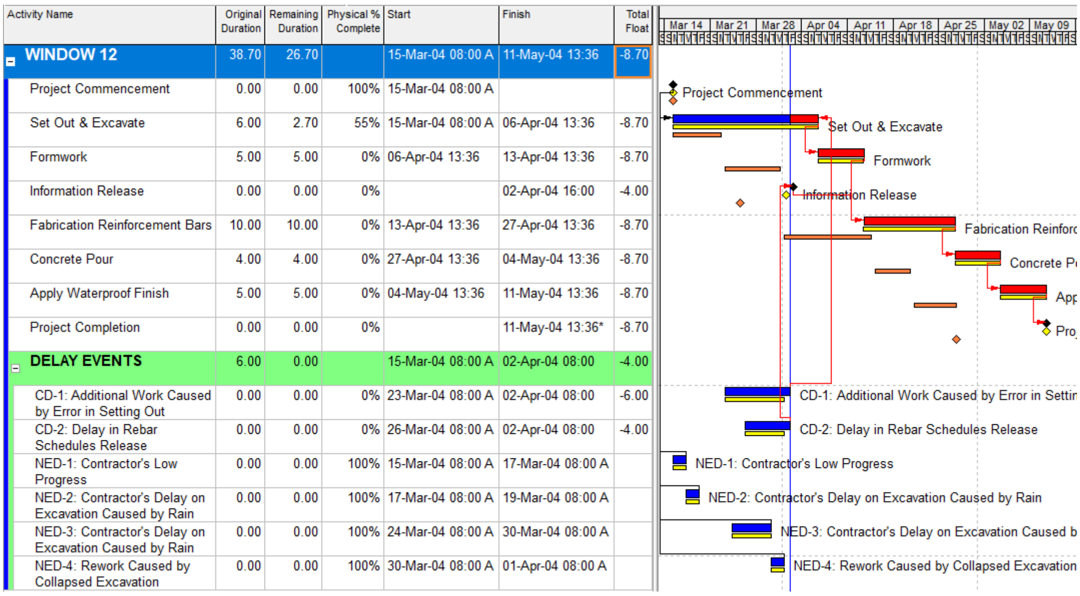
3.2.1.12 Window 12 – From 01 April 2004 08:00 to 02 April 2004 08:00

As also shown in Figure 12, the daily progress records for 01-Apr-04 were as follows:

- Good progress was achieved on Set Out & Excavate activity. The cumulative percentage of completed activity is reported by the Contractor as 55%.
- Additional work caused by setting out error were continued. Formwork to fill the redundant excavation is carried out.
- Rebar schedules are still not released by the Employer.

The cumulative progress of Set Out & Excavate is 55% and consequently the earned duration of the activity is 3.3 days. Hence, the estimated remaining duration of the activity is updated in the program as 2.7 days.

Figure 49 shows the updated program for Window 12. The project completion date is kept as 11-May-04, which means there is no delay compared to the previous window, and a 14-calendar-day delay compared to the as-planned program. Hence, there is no delay in the critical path in this window. In addition to that, the effect of delay events, CD-1: Additional Work Caused by Error in Setting Out and CD-2: Delay in Rebar Schedules Release, that caused concurrent delay are continued.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 12	38.70	26.70		15-Mar-04 08:00 A	11-May-04 13:36	-8.70
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	2.70	55%	15-Mar-04 08:00 A	06-Apr-04 13:36	-8.70
Formwork	5.00	5.00	0%	06-Apr-04 13:36	13-Apr-04 13:36	-8.70
Information Release	0.00	0.00	0%		02-Apr-04 16:00	-4.00
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 13:36	27-Apr-04 13:36	-8.70
Concrete Pour	4.00	4.00	0%	27-Apr-04 13:36	04-May-04 13:36	-8.70
Apply Waterproof Finish	5.00	5.00	0%	04-May-04 13:36	11-May-04 13:36	-8.70
Project Completion	0.00	0.00	0%		11-May-04 13:36*	-8.70
DELAY EVENTS	6.00	0.00		15-Mar-04 08:00 A	02-Apr-04 08:00	-4.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	02-Apr-04 08:00	-6.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	02-Apr-04 08:00	-4.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	

Figure 49 Updated Program for Window 12

Figure 50 shows the float paths to Project Completion milestone on the updated program. Float Path 1 delays the Project Completion milestone date to 11-May-04, which means a 14-calendar-days delay compared to the as-planned program. In addition to that, Float Path 2, which contains the delay event of CD-1: Additional Work Caused by Error in Setting Out, also delays the project with a concurrent effect. Since the total float of the delay event is -6 days, it has a 6-working-day schedule impact which pushes the project completion date to 06-May-04. Furthermore, Float Path 3, which contains the delay event of CD-2: Delay in Rebar Schedules Release, also delays the project with a concurrent effect. Since the total float of the delay event is -4 days, it has a 4-working-day schedule impact, which pushes the project completion date to 04-May-04.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	38.70	26.70		15-Mar-04 08:00 A	11-May-04 13:36	-8.70
Set Out & Excavate	6.00	2.70	55%	15-Mar-04 08:00 A	06-Apr-04 13:36	-8.70
Formwork	5.00	5.00	0%	06-Apr-04 13:36	13-Apr-04 13:36	-8.70
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 13:36	27-Apr-04 13:36	-8.70
Concrete Pour	4.00	4.00	0%	27-Apr-04 13:36	04-May-04 13:36	-8.70
Apply Waterproof Finish	5.00	5.00	0%	04-May-04 13:36	11-May-04 13:36	-8.70
Project Completion	0.00	0.00	0%		11-May-04 13:36*	-8.70
2	0.00	0.00		23-Mar-04 08:00 A	02-Apr-04 08:00	-6.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	02-Apr-04 08:00	-6.00
3	7.00	1.00		26-Mar-04 08:00 A	02-Apr-04 16:00	-4.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	02-Apr-04 08:00	-4.00
Information Release	0.00	0.00	0%		02-Apr-04 16:00	-4.00

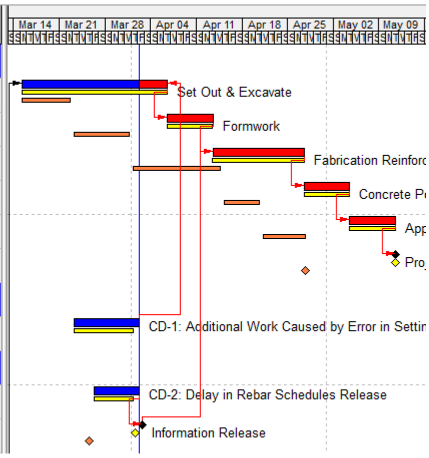


Figure 50 Float Paths of Updated Program for Window 12

The results of Window 12 of the delay analysis are shown in a summary format in Figure 51. In the path from Set Out & Excavate to Project Completion, there is a 14-calendar-day non-excusable delay coming from Float Path 1. There is also a 9-calendar-day compensable delay in the same path which is coming from Float Path 2 caused by delay event CD-1: Additional Work Caused by Error in Setting Out. Due to that, there is a concurrent effect of a 9-calendar-day non-excusable delay and compensable delay on the project completion milestone. Whenever non-excusable delay and compensable delay have a concurrent effect, the delay is considered to be an excusable delay, which gives entitlement to extension of time but not to prolongation costs. Furthermore, in the path from Information Release to Project Completion, there is 7-calendar-day compensable delay which is coming from Float Path 3 caused by delay event CD-2: Delay in Rebar Schedules Release.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 12																												
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	CD-1: Add. Work Caused by Error in Setting	27-Apr-04	11-May-04	11-May-04	14	0	9	5										06-May-04					11-May-04		
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	30-Apr-04	04-May-04	7	7	0	0									04-May-04								

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 51 Time Slice Windows Analysis Results for Window 12

3.2.1.13 Window 13 – From 02 April 2004 08:00 to 05 April 2004 08:00

02-Apr-04 was a working day, and 03-Apr-04 and 04-Apr-04 were non-working days. As also shown in Figure 12, the daily progress records for 02-Apr-04 were as follows:

- Good progress maintained in excavation work despite rainy weather. The cumulative percentage of completed Set Out & Excavate activity is reported by the Contractor as 70%.
- Additional work caused by the setting out error has been completed. Mass concrete fill to redundant excavation is performed.
- Rebar schedules are still not released by the Employer.

The cumulative progress of Set Out & Excavate is 70% and consequently the earned duration of the activity is 4.2 days. Hence, the estimated remaining duration of the activity is updated in the program as 1.8 days.

Figure 52 shows the updated program for Window 13. The project completion date is kept as 11-May-04, which means there is no delay compared to the previous window and a 14-calendar-day delay compared to the as-planned program. Hence, there is no delay in the critical path in this window. In addition, the effect of delay events, CD-1: Additional Work Caused by Error in Setting Out and CD-2: Delay in Rebar Schedules Release, which caused concurrent delay to project completion, are continued in this window. Even though additional work caused by an error in setting out was completed on 02-Apr-04, to see the effect of it on the float path in this window, the delay event activity is closed on 05-Apr-04 since effect of this delay event began to not be felt on the project on 05-Apr-04.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 13	38.80	25.80		15-Mar-04 08:00 A	11-May-04 14:24	-8.80
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	1.80	70%	15-Mar-04 08:00 A	06-Apr-04 14:24	-8.80
Formwork	5.00	5.00	0%	06-Apr-04 14:24	13-Apr-04 14:24	-8.80
Information Release	0.00	0.00	0%		05-Apr-04 16:00	-5.00
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 14:24	27-Apr-04 14:24	-8.80
Concrete Pour	4.00	4.00	0%	27-Apr-04 14:24	04-May-04 14:24	-8.80
Apply Waterproof Finish	5.00	5.00	0%	04-May-04 14:24	11-May-04 14:24	-8.80
Project Completion	0.00	0.00	0%		11-May-04 14:24*	-8.80
DELAY EVENTS	6.00	0.00		15-Mar-04 08:00 A	05-Apr-04 08:00	-5.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	05-Apr-04 08:00	-7.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	05-Apr-04 08:00	-5.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	

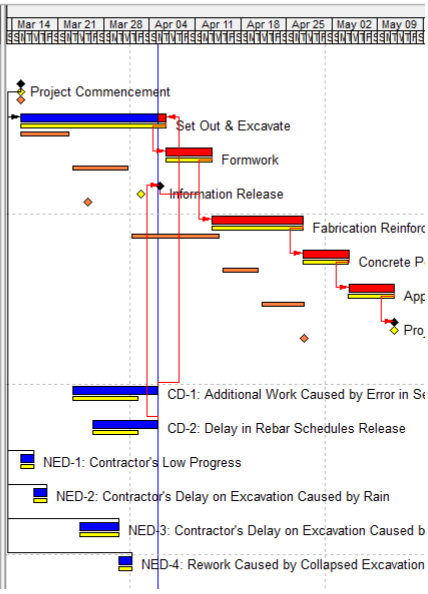
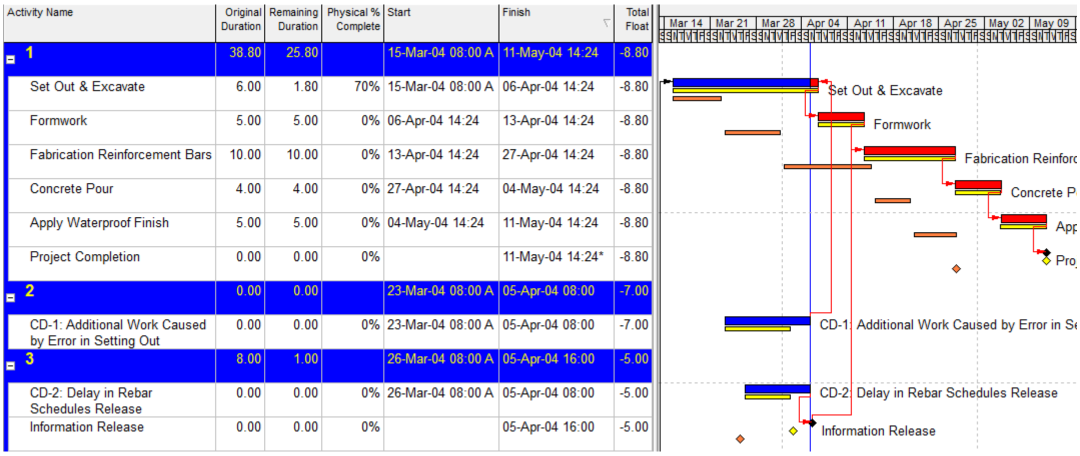


Figure 52 Updated Program for Window 13

Figure 53 shows the float paths to Project Completion milestone on the updated program. Float Path 1 delays the Project Completion milestone date to 11-May-04, which means a 14-calendar-day delay compared to the as-planned program. In addition to that, Float Path 2, which contains delay event of CD-1: Additional Work Caused by Error in Setting Out, also delays the project with a concurrent effect. Since the total float of the delay event is -7 days, it has a 7-working-day schedule impact which pushes the project completion date to 07-May-04. Furthermore, Float Path 3, which contains delay event of CD-2: Delay in Rebar Schedules Release, also delays the project with a concurrent effect. Since the total float of the delay event is -5 days, it has a 5-working-day schedule impact which pushes the project completion date to 05-May-04.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	38.80	25.80		15-Mar-04 08:00 A	11-May-04 14:24	-8.80
Set Out & Excavate	6.00	1.80	70%	15-Mar-04 08:00 A	06-Apr-04 14:24	-8.80
Formwork	5.00	5.00	0%	06-Apr-04 14:24	13-Apr-04 14:24	-8.80
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 14:24	27-Apr-04 14:24	-8.80
Concrete Pour	4.00	4.00	0%	27-Apr-04 14:24	04-May-04 14:24	-8.80
Apply Waterproof Finish	5.00	5.00	0%	04-May-04 14:24	11-May-04 14:24	-8.80
Project Completion	0.00	0.00	0%		11-May-04 14:24*	-8.80
2	0.00	0.00		23-Mar-04 08:00 A	05-Apr-04 08:00	-7.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	0%	23-Mar-04 08:00 A	05-Apr-04 08:00	-7.00
3	8.00	1.00		26-Mar-04 08:00 A	05-Apr-04 16:00	-5.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	05-Apr-04 08:00	-5.00
Information Release	0.00	0.00	0%		05-Apr-04 16:00	-5.00

Figure 53 Float Paths of Updated Program for Window 13

The results of Window 13 of the delay analysis are shown in a summary format in Figure 54. In the path from Set Out & Excavate to Project Completion, there is a 14-calendar-day non-excusable delay coming from Float Path 1. There is also a 10-calendar-day compensable delay in the same path which is coming from Float Path 2, which is caused by delay event CD-1: Additional Work Caused by Error in Setting Out. Due to that, there is a concurrent effect of a 10-calendar-day non-excusable delay and compensable delay on the project completion milestone. Whenever non-excusable delay and compensable delay have a concurrent effect, the delay type is considered as an excusable delay, which gives entitlement to extension of time but not prolongation costs. Furthermore, in the path from Information Release to Project Completion, there is 8-calendar-day compensable delay coming from Float Path 3 caused by delay event CD-2: Delay in Rebar Schedules Release.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 13

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays Tot.	CD	ED	NED	27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
Set Out & Exc. to Project Comp.	Set Out & Excavate	CD-1: Add. Work Caused by Error in Setting	27-Apr-04	11-May-04	11-May-04	14	0	10	4											07-May-04				11-May-04		
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	04-May-04	05-May-04	8	8	0	0									05-May-04								

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 54 Time Slice Windows Analysis Results for Window 13

3.2.1.14 Window 14 – From 05 April 2004 08:00 to 06 April 2004 08:00

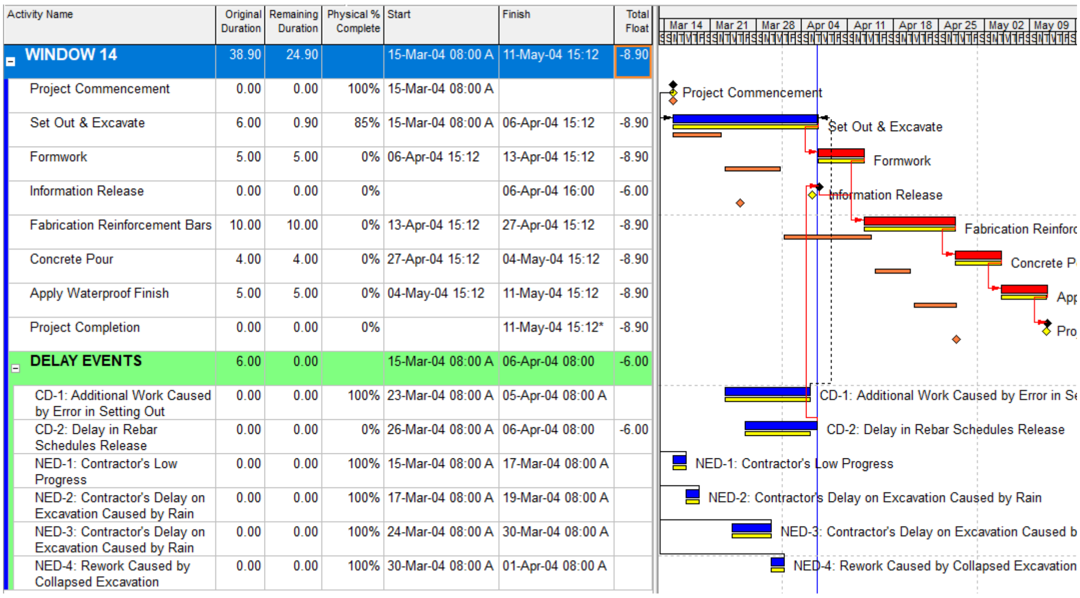
As also shown in Figure 12, the daily progress records for 05-Apr-04 were as follows:

- The cumulative percentage of completed Set Out & Excavate activity is reported by the Contractor as 85%.
- Rebar schedules are still not released by the Employer.

The cumulative progress of Set Out & Excavate is 85% and consequently the earned duration of the activity is 5.1 days. Hence, the estimated remaining duration of the activity is updated in the program as 0.9 days.

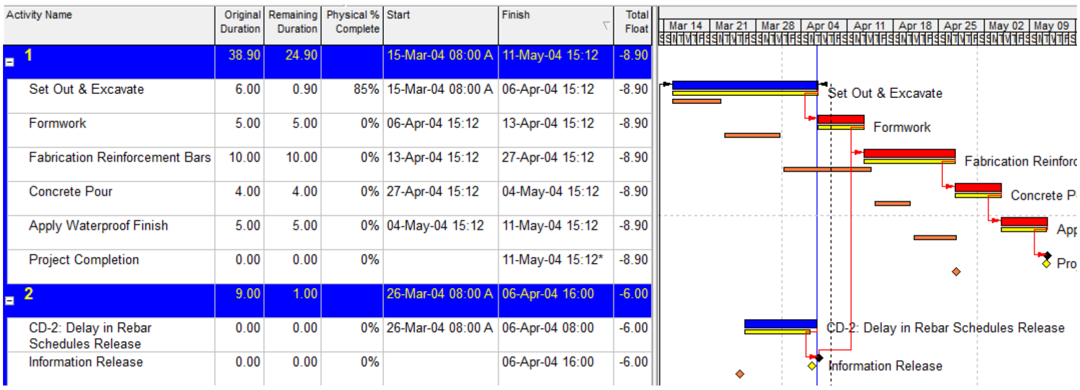
Figure 55 shows the updated program for Window 14. The project completion date is kept as 11-May-04, which means there is no delay compared to the previous window, and a delay of 14 calendar days compared to the as-planned program. Hence, there is no delay in the critical path in this window. Furthermore, the work related to delay event of CD-1: Additional Work Caused by Error in Setting Out are completed and there is no effect on the project completion date due to this delay event in this window. In addition, the effect of delay event CD-2: Delay in Rebar Schedules Release that caused a concurrent delay to project completion is continued in this window.

Figure 56 shows the float paths to the Project Completion milestone on the updated program. Float Path 1 delays the Project Completion milestone date to 11-May-04, which means a delay of 14 calendar days compared to the as-planned program. In addition to that, Float Path 2, which contains the delay event of CD-2: Delay in Rebar Schedules Release, also delays the project with a concurrent effect. Since the total float of the delay event is -6 days, it has a 6-working-day schedule impact, which pushes the project completion date to 06-May-04.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 14	38.90	24.90		15-Mar-04 08:00 A	11-May-04 15:12	-8.90
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.90	85%	15-Mar-04 08:00 A	06-Apr-04 15:12	-8.90
Formwork	5.00	5.00	0%	06-Apr-04 15:12	13-Apr-04 15:12	-8.90
Information Release	0.00	0.00	0%		06-Apr-04 16:00	-6.00
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 15:12	27-Apr-04 15:12	-8.90
Concrete Pour	4.00	4.00	0%	27-Apr-04 15:12	04-May-04 15:12	-8.90
Apply Waterproof Finish	5.00	5.00	0%	04-May-04 15:12	11-May-04 15:12	-8.90
Project Completion	0.00	0.00	0%		11-May-04 15:12*	-8.90
DELAY EVENTS	6.00	0.00		15-Mar-04 08:00 A	06-Apr-04 08:00	-6.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	06-Apr-04 08:00	-6.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	

Figure 55 Updated Program for Window 14



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	38.90	24.90		15-Mar-04 08:00 A	11-May-04 15:12	-8.90
Set Out & Excavate	6.00	0.90	85%	15-Mar-04 08:00 A	06-Apr-04 15:12	-8.90
Formwork	5.00	5.00	0%	06-Apr-04 15:12	13-Apr-04 15:12	-8.90
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 15:12	27-Apr-04 15:12	-8.90
Concrete Pour	4.00	4.00	0%	27-Apr-04 15:12	04-May-04 15:12	-8.90
Apply Waterproof Finish	5.00	5.00	0%	04-May-04 15:12	11-May-04 15:12	-8.90
Project Completion	0.00	0.00	0%		11-May-04 15:12*	-8.90
2	9.00	1.00		26-Mar-04 08:00 A	06-Apr-04 16:00	-6.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	06-Apr-04 08:00	-6.00
Information Release	0.00	0.00	0%		06-Apr-04 16:00	-6.00

Figure 56 Float Paths of Updated Program for Window 14

The results of Window 14 of the delay analysis are shown in a summary format in Figure 57. In the path from Set Out & Excavate to Project Completion, there was no delay in this window and the results are reported the same as in the previous window. In addition, in the path from Information Release to Project Completion, there is a 9-calendar-day compensable delay coming from Float Path 3 caused by delay event CD-2: Delay in Rebar Schedules Release.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 14																													
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	No Delay This Window	27-Apr-04	11-May-04	11-May-04	14	0	10	4											07-May-04				11-May-04		
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	05-May-04	06-May-04	9	9	0	0											06-May-04						

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 57 Time Slice Windows Analysis Results for Window 14

3.2.1.15 Window 15 – From 06 April 2004 08:00 to 07 April 2004 08:00

As also shown in Figure 12, the daily progress records for 06-Apr-04 were as follows:

- Excavations completed. The cumulative percentage of completed Set Out & Excavate activity is reported by the Contractor as 100%.
- Rebar schedules are still not released by the Employer.

Figure 58 shows the updated program for Window 15. The project completion date is kept as 11-May-04, which means there is no delay compared to the previous Window and a delay of 14 calendar days compared to the as-planned program. Hence, there is no delay in the critical path in this window. The Set Out & Excavate activity is completed, and Formwork activity is ready to be started. In addition to that, the effect of delay event CD-2: Delay in Rebar Schedules Release that caused concurrent delay to project completion is continued in this window.

Figure 59 shows the float paths to Project Completion milestone on the updated program. Float Path 1 delays the project completion milestone date to 11-May-04, which means a 14-calendar-day delay compared to the as-planned program. In addition, Float Path 2, which contains delay event of CD-2: Delay in Rebar Schedules Release, also delays the project with a concurrent effect. Since the total float of the delay event is -7 days, it has a 7-working-day schedule impact, which pushes the project completion date to 07-May-04.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 15	39.00	24.00		15-Mar-04 08:00 A	11-May-04 16:00	-9.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	5.00	0%	07-Apr-04 08:00	13-Apr-04 16:00	-9.00
Information Release	0.00	0.00	0%		07-Apr-04 16:00	-7.00
Fabrication Reinforcement Bars	10.00	10.00	0%	14-Apr-04 08:00	27-Apr-04 16:00	-9.00
Concrete Pour	4.00	4.00	0%	28-Apr-04 08:00	04-May-04 16:00	-9.00
Apply Waterproof Finish	5.00	5.00	0%	05-May-04 08:00	11-May-04 16:00	-9.00
Project Completion	0.00	0.00	0%		11-May-04 16:00*	-9.00
DELAY EVENTS	6.00	0.00		15-Mar-04 08:00 A	07-Apr-04 08:00	-7.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	07-Apr-04 08:00	-7.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	

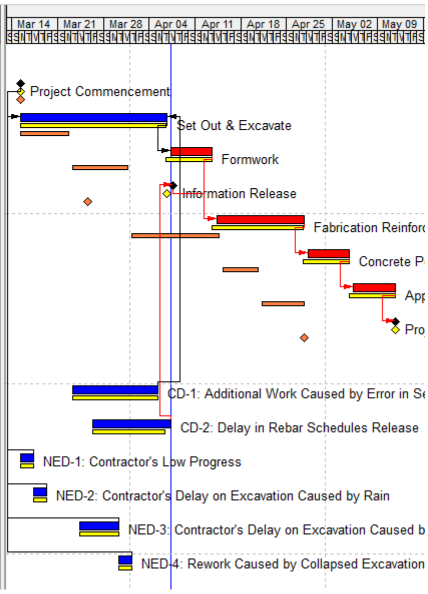


Figure 58 Updated Program for Window 15

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	24.00	24.00		07-Apr-04 08:00	11-May-04 16:00	-9.00
Formwork	5.00	5.00	0%	07-Apr-04 08:00	13-Apr-04 16:00	-9.00
Fabrication Reinforcement Bars	10.00	10.00	0%	14-Apr-04 08:00	27-Apr-04 16:00	-9.00
Concrete Pour	4.00	4.00	0%	28-Apr-04 08:00	04-May-04 16:00	-9.00
Apply Waterproof Finish	5.00	5.00	0%	05-May-04 08:00	11-May-04 16:00	-9.00
Project Completion	0.00	0.00	0%		11-May-04 16:00*	-9.00
2	10.00	1.00		26-Mar-04 08:00 A	07-Apr-04 16:00	-7.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	07-Apr-04 08:00	-7.00
Information Release	0.00	0.00	0%		07-Apr-04 16:00	-7.00

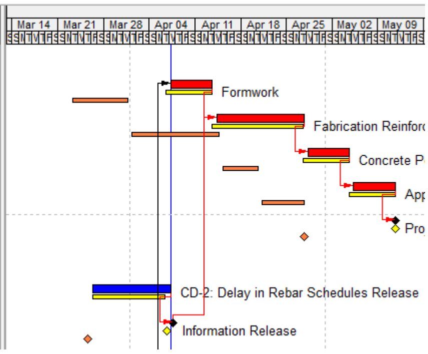
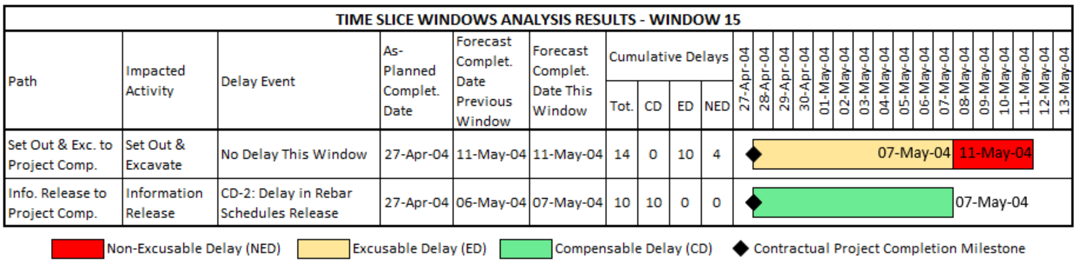


Figure 59 Float Paths of Updated Program for Window 15

The results of Window 15 of the delay analysis are shown in a summary format in Figure 60. In the path from Set Out & Excavate to Project Completion, there was no delay in this window and the results are reported the same as those of the previous window. In addition, in the path from Information Release to Project Completion, there is a compensable delay of 10 calendar days coming from Float Path 3, which is caused by delay event CD-2: Delay in Rebar Schedules Release.



TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 15																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Set Out & Excavate	No Delay This Window	27-Apr-04	11-May-04	11-May-04	14	0	10	4											07-May-04				11-May-04		
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	06-May-04	07-May-04	10	10	0	0												07-May-04					

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 60 Time Slice Windows Analysis Results for Window 15

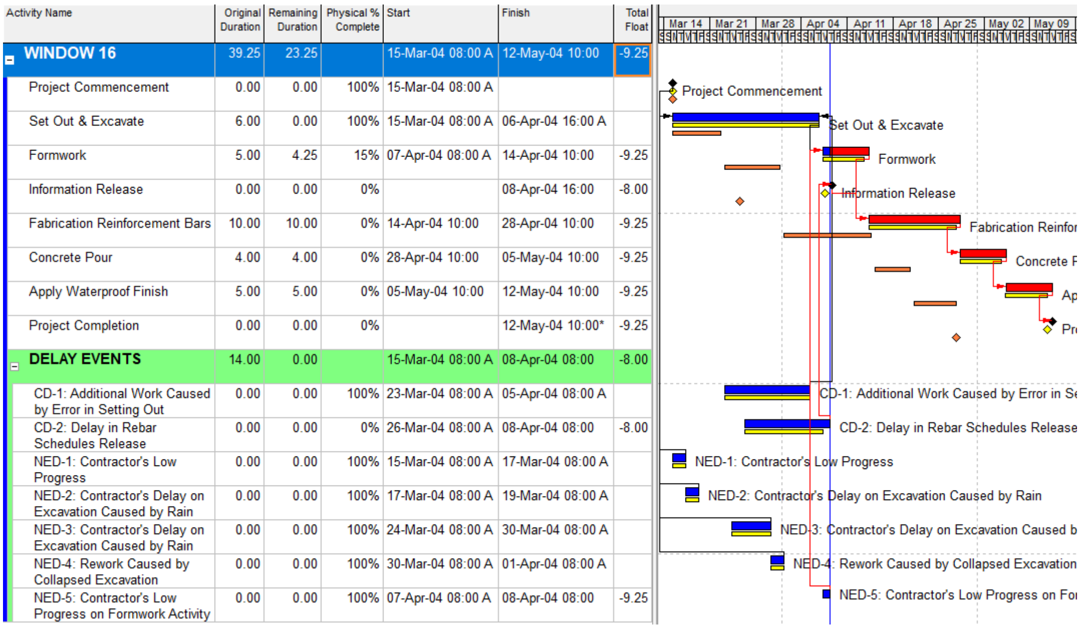
3.2.1.16 Window 16 – From 07 April 2004 08:00 to 08 April 2004 08:00

As also shown in Figure 12, the daily progress records for 07-Apr-04 were as follows:

- Formwork activity started with 2 workers. The cumulative percentage of completed Formwork activity is reported by the Contractor as 15%.
- The Contractor provided test data for Admix, which the Employer considers to be used in the concrete for waterproofing, is provided to Employer.
- Rebar schedules are still not released by the Employer.

Since the cumulative progress of Formwork activity is 15% and the planned duration of the activity was 5 days, the earned duration of the activity is 0.75 days. Hence, the estimated remaining duration is updated in the program as 4.25 days. The Contractor’s actual progress on Formwork activity is lower than the planned progress which was 20%. The delay was caused by low performance of the Contractor compared to the as-planned program.

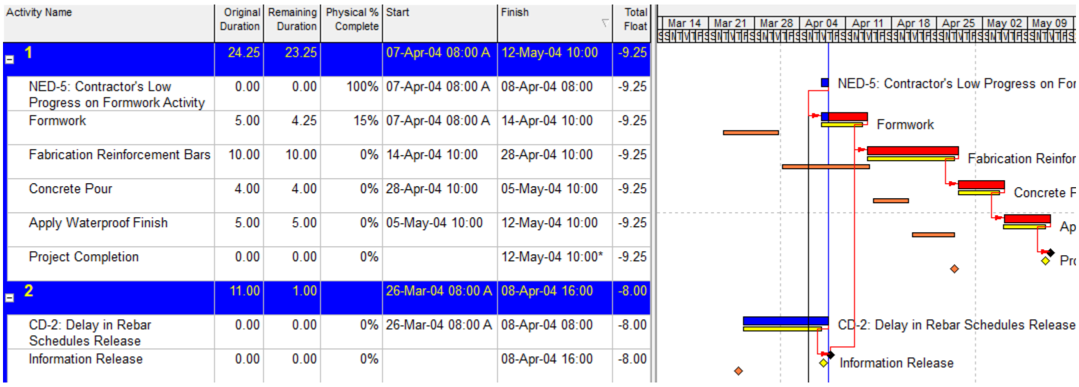
Figure 61 shows the updated program for Window 16. The project completion date is shifted to 12-May-04, which means there is a 1-calendar-day delay compared to the previous window and a 15-calendar-day delay compared to the as-planned program. The critical delay occurred due to low performance of the Contractor on Formwork activity. An activity representing this non-excusable delay event is created as NED-5: Contractor’s Low Progress on Formwork Activity. The delay event is linked with Formwork activity as it is the cause of the delay that occurred in Formwork activity. Furthermore, the effect of delay event CD-2: Delay in Rebar Schedules Release that caused concurrent delay to project completion is continued in this window.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 16	39.25	23.25		15-Mar-04 08:00 A	12-May-04 10:00	-9.25
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	4.25	15%	07-Apr-04 08:00 A	14-Apr-04 10:00	-9.25
Information Release	0.00	0.00	0%		08-Apr-04 16:00	-8.00
Fabrication Reinforcement Bars	10.00	10.00	0%	14-Apr-04 10:00	28-Apr-04 10:00	-9.25
Concrete Pour	4.00	4.00	0%	28-Apr-04 10:00	05-May-04 10:00	-9.25
Apply Waterproof Finish	5.00	5.00	0%	05-May-04 10:00	12-May-04 10:00	-9.25
Project Completion	0.00	0.00	0%		12-May-04 10:00*	-9.25
DELAY EVENTS	14.00	0.00		15-Mar-04 08:00 A	08-Apr-04 08:00	-8.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	08-Apr-04 08:00	-8.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	08-Apr-04 08:00	-9.25

Figure 61 Updated Program for Window 16

Figure 62 shows the float paths to Project Completion milestone on the updated program. Float Path 1, which contains NED-5: Contractor's Low Progress on Formwork Activity, delays the Project Completion milestone date to 12-May-04, which means a delay of 15 calendar days delay to as-planned program. Furthermore, Float Path 2, which contains delay event CD-2: Delay in Rebar Schedules Release, also delays the project with a concurrent effect. Since the total float of the delay event is -8 days, it has an 8-working-day schedule impact, which pushes the project completion date to 10-May-04.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	24.25	23.25		07-Apr-04 08:00 A	12-May-04 10:00	-9.25
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	08-Apr-04 08:00	-9.25
Formwork	5.00	4.25	15%	07-Apr-04 08:00 A	14-Apr-04 10:00	-9.25
Fabrication Reinforcement Bars	10.00	10.00	0%	14-Apr-04 10:00	28-Apr-04 10:00	-9.25
Concrete Pour	4.00	4.00	0%	28-Apr-04 10:00	05-May-04 10:00	-9.25
Apply Waterproof Finish	5.00	5.00	0%	05-May-04 10:00	12-May-04 10:00	-9.25
Project Completion	0.00	0.00	0%		12-May-04 10:00*	-9.25
2	11.00	1.00		26-Mar-04 08:00 A	08-Apr-04 16:00	-8.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	08-Apr-04 08:00	-8.00
Information Release	0.00	0.00	0%		08-Apr-04 16:00	-8.00

Figure 62 Float Paths of Updated Program for Window 16

The results of Window 16 of the delay analysis are shown in a summary format in Figure 63. There is a 1-calendar-day non-excusable delay on the Project Completion milestone in this window, which increased the cumulative delay to 15 calendar days on the path from Set Out & Excavate to Project Completion, as shown in Float Path 1. Furthermore, there is also a compensable delay of 13 calendar days on the path from Information Release to Project Completion.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 16

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays Tot.	Cumulative Delays CD	Cumulative Delays ED	Cumulative Delays NED	27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
Set Out & Exc. to Project Comp.	Formwork	NED-5: Contractor's Low Progress on Formwork	27-Apr-04	11-May-04	12-May-04	15	0	10	5											07-May-04					12-May-04	
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	07-May-04	10-May-04	13	13	0	0														10-May-04			

Non-Excusable Delay (NED) — Excusable Delay (ED) — Compensable Delay (CD) — ◆ Contractual Project Completion Milestone

Figure 63 Time Slice Windows Analysis Results for Window 16

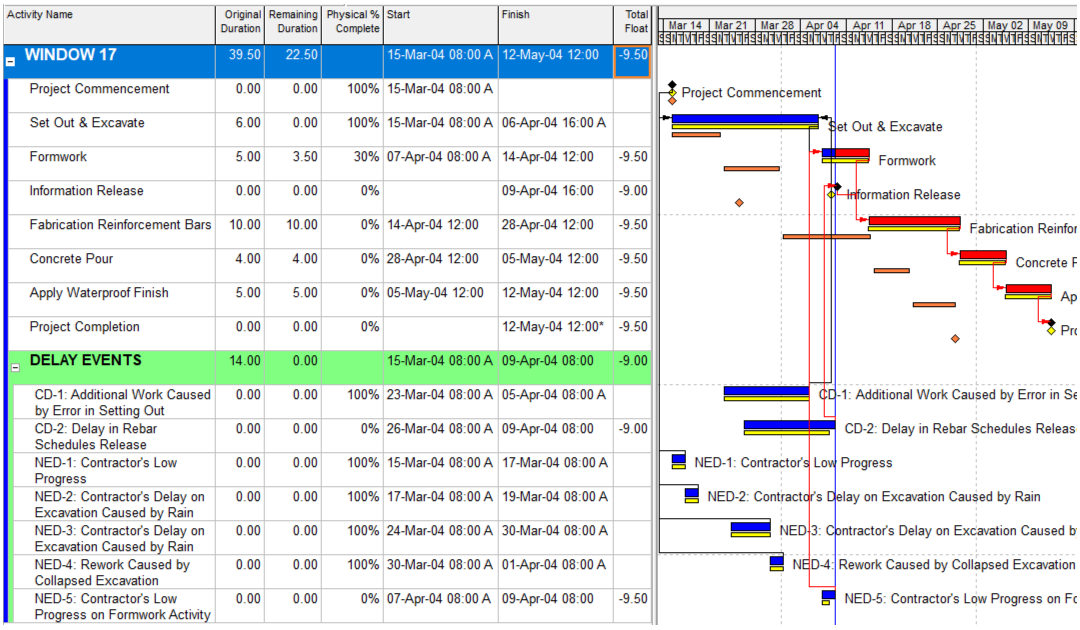
3.2.1.17 Window 17 – From 08 April 2004 08:00 to 09 April 2004 08:00

As also shown in Figure 12, the daily progress records for 08-Apr-04 were as follows:

- The actual progress of Formwork activity was lower than planned. The Contractor planned to add more resources to the work. The cumulative percentage of completed Formwork activity is reported by the Contractor as 30%.
- Rebar schedules are still not released by the Employer.

Since the cumulative progress of Formwork activity is 30% and planned duration of the activity was 5 days, the earned duration of the activity is 1.5 days. Hence, the estimated remaining duration is updated in the program as 3.5 days.

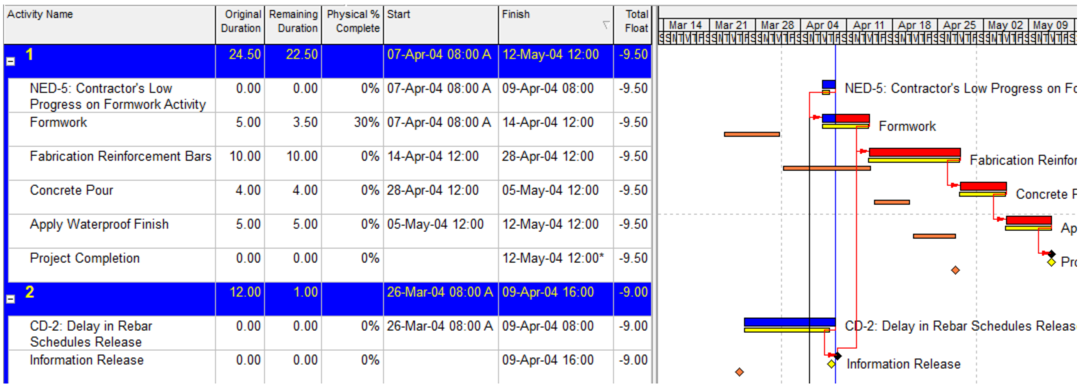
Figure 64 shows the updated program for Window 17. The project completion date is kept as 12-May-04 which means there is no critical delay compared to the previous window, and 15 calendar days delay compared to the as-planned program. Furthermore, the effect of delay event CD-2: Delay in Rebar Schedules Release that caused concurrent delay to project completion is continued in this window.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 17	39.50	22.50		15-Mar-04 08:00 A	12-May-04 12:00	-9.50
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	3.50	30%	07-Apr-04 08:00 A	14-Apr-04 12:00	-9.50
Information Release	0.00	0.00	0%		09-Apr-04 16:00	-9.00
Fabrication Reinforcement Bars	10.00	10.00	0%	14-Apr-04 12:00	28-Apr-04 12:00	-9.50
Concrete Pour	4.00	4.00	0%	28-Apr-04 12:00	05-May-04 12:00	-9.50
Apply Waterproof Finish	5.00	5.00	0%	05-May-04 12:00	12-May-04 12:00	-9.50
Project Completion	0.00	0.00	0%		12-May-04 12:00*	-9.50
DELAY EVENTS	14.00	0.00		15-Mar-04 08:00 A	09-Apr-04 08:00	-9.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	09-Apr-04 08:00	-9.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	0%	07-Apr-04 08:00 A	09-Apr-04 08:00	-9.50

Figure 64 Updated Program for Window 17

Figure 65 shows the float paths to Project Completion milestone on the updated program. Float Path 1, which contains NED-5: Contractor's Low Progress on Formwork Activity, delays the project completion date to 12-May-04, and this means there is a 15-calendar-day delay compared to the as-planned program. Float Path 2, which contains delay event of CD-2: Delay in Rebar Schedules Release, also delays the project with a concurrent effect. Since the total float of the delay event is -9 days, it has a 9 working day impact that pushes the project completion date to 11-May-04.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	24.50	22.50		07-Apr-04 08:00 A	12-May-04 12:00	-9.50
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	0%	07-Apr-04 08:00 A	09-Apr-04 08:00	-9.50
Formwork	5.00	3.50	30%	07-Apr-04 08:00 A	14-Apr-04 12:00	-9.50
Fabrication Reinforcement Bars	10.00	10.00	0%	14-Apr-04 12:00	28-Apr-04 12:00	-9.50
Concrete Pour	4.00	4.00	0%	28-Apr-04 12:00	05-May-04 12:00	-9.50
Apply Waterproof Finish	5.00	5.00	0%	05-May-04 12:00	12-May-04 12:00	-9.50
Project Completion	0.00	0.00	0%		12-May-04 12:00*	-9.50
2	12.00	1.00		26-Mar-04 08:00 A	09-Apr-04 16:00	-9.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	09-Apr-04 08:00	-9.00
Information Release	0.00	0.00	0%		09-Apr-04 16:00	-9.00

Figure 65 Float Paths of Updated Program for Window 17

The results of Window 17 are shown in a summary format in Figure 66. There is no critical delay on critical path which is the path from Set Out & Excavate to Project Completion in this window. Therefore, the overall delay on project completion is kept same as previous window as 15 calendar days. Furthermore, there is also a 14-day compensable delay on the path from Information Release to Project Completion.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 17

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays Tot.	CD	ED	NED	27-Apr-04 … 13-May-04
Set Out & Exc. to Project Comp.	Formwork	NED-5: Contractor's Low Progress on Formwork	27-Apr-04	12-May-04	12-May-04	15	0	10	5	◆ 07-May-04 12-May-04
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	10-May-04	11-May-04	14	14	0	0	◆ 11-May-04

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 66 Time Slice Windows Analysis Results for Window 17

3.2.1.18 Window 18 – From 09 April 2004 08:00 to 12 April 2004 08:00

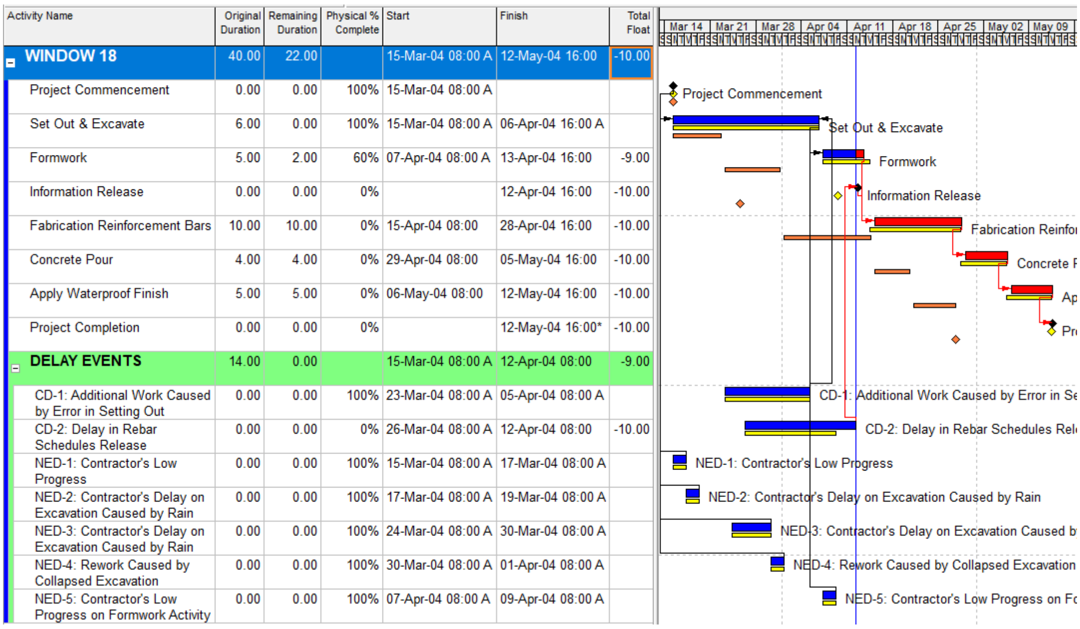
09-Apr-04 was a working day, and 10-Apr-04 and 11-Apr-04 were non-working days. As also shown in Figure 12, the daily progress records for 09-Apr-04 were as follows:

- 2 new workers started working on the Formwork activity. Good progress was achieved. The cumulative percentage of completed Formwork activity is reported by the Contractor as 60%.
- Rebar schedules are still not released by the Employer.

Since the cumulative progress of Formwork activity is 60% and the planned duration of the activity was 5 days, the earned duration of the activity is 3 days. Hence, the estimated remaining duration is updated in the program as 2 days.

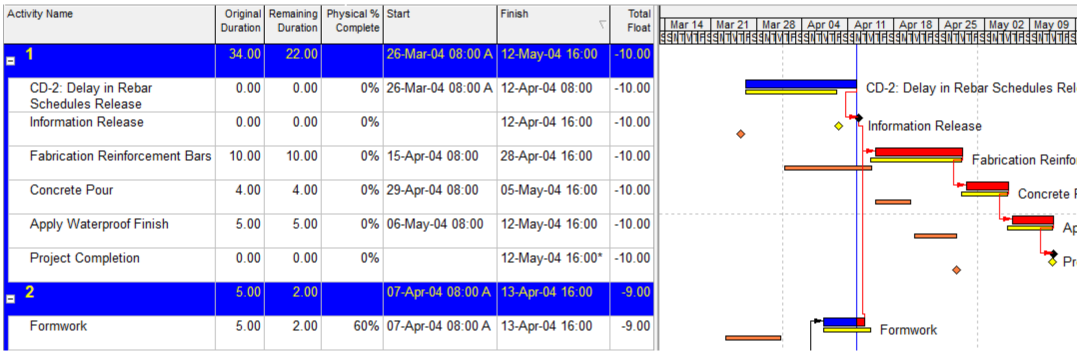
Figure 67 shows the updated program for Window 18. The project completion date is kept as 12-May-04, which means there is no critical delay compared to the previous window and a 15-calendar-day delay compared to the as-planned program. However, there is a change in the critical path of the project. The critical path of the project is from Information Release to Project Completion in this window due to the delay caused by CD-2: Delay in Rebar Schedules Release. Formwork activity is accelerated by the Contractor as new resources are added to the activity in this Window. Hence, the finish date of the activity is reduced by 1 day compared to the previous window.

Figure 68 shows the float paths to Project Completion milestone on the updated program. Float Path 1, which contains CD-2: Delay in Rebar Schedules Release, delays the Project Completion milestone date to 12-May-04, which means a 15-calendar-day delay compared to the as-planned program. Furthermore, Float Path 2, which contains Formwork activity, also delays the project with a concurrent effect. Since the total float of the delay event is -9 days, it has a 9-working-day schedule impact, which pushes the project completion date to 11-May-04. The non-excusable delay occurring in the Formwork activity due to low progress is eliminated in this window, as the forecasted duration of the activity is 5 days which is same as the planned duration.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 18	40.00	22.00		15-Mar-04 08:00 A	12-May-04 16:00	-10.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	2.00	60%	07-Apr-04 08:00 A	13-Apr-04 16:00	-9.00
Information Release	0.00	0.00	0%		12-Apr-04 16:00	-10.00
Fabrication Reinforcement Bars	10.00	10.00	0%	15-Apr-04 08:00	28-Apr-04 16:00	-10.00
Concrete Pour	4.00	4.00	0%	29-Apr-04 08:00	05-May-04 16:00	-10.00
Apply Waterproof Finish	5.00	5.00	0%	06-May-04 08:00	12-May-04 16:00	-10.00
Project Completion	0.00	0.00	0%		12-May-04 16:00*	-10.00
DELAY EVENTS	14.00	0.00		15-Mar-04 08:00 A	12-Apr-04 08:00	-9.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	12-Apr-04 08:00	-10.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	

Figure 67 Updated Program for Window 18



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	34.00	22.00		26-Mar-04 08:00 A	12-May-04 16:00	-10.00
CD-2: Delay in Rebar Schedules Release	0.00	0.00	0%	26-Mar-04 08:00 A	12-Apr-04 08:00	-10.00
Information Release	0.00	0.00	0%		12-Apr-04 16:00	-10.00
Fabrication Reinforcement Bars	10.00	10.00	0%	15-Apr-04 08:00	28-Apr-04 16:00	-10.00
Concrete Pour	4.00	4.00	0%	29-Apr-04 08:00	05-May-04 16:00	-10.00
Apply Waterproof Finish	5.00	5.00	0%	06-May-04 08:00	12-May-04 16:00	-10.00
Project Completion	0.00	0.00	0%		12-May-04 16:00*	-10.00
2	5.00	2.00		07-Apr-04 08:00 A	13-Apr-04 16:00	-9.00
Formwork	5.00	2.00	60%	07-Apr-04 08:00 A	13-Apr-04 16:00	-9.00

Figure 68 Float Paths of Updated Program for Window 18

The results of Window 18 of the delay analysis are shown in a summary format in Figure 69. There is 15 days compensable delay on the critical path, which is the path from Information Release to Project Completion, as it is delayed by CD-2: Delay in Rebar Schedules Release. The 1-day delay that occurred on Formwork activity due to low progress in Window 16 is eliminated by the Contractor by accelerating the activity in this window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 18																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Info. Release to Project Comp.	Information Release	CD-2: Delay in Rebar Schedules Release	27-Apr-04	11-May-04	12-May-04	15	15	0	0	◆															12-May-04	
Set Out & Exc. to Project Comp.	Formwork	Acceleration This Window	27-Apr-04	12-May-04	11-May-04	14	0	10	4	◆										07-May-04				11-May-04		

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 69 Time Slice Windows Analysis Results for Window 18

3.2.1.19 Window 19 – From 12 April 2004 08:00 to 13 April 2004 08:00

As also shown in Figure 12, the daily progress records for 12-Apr-04 were as follows:

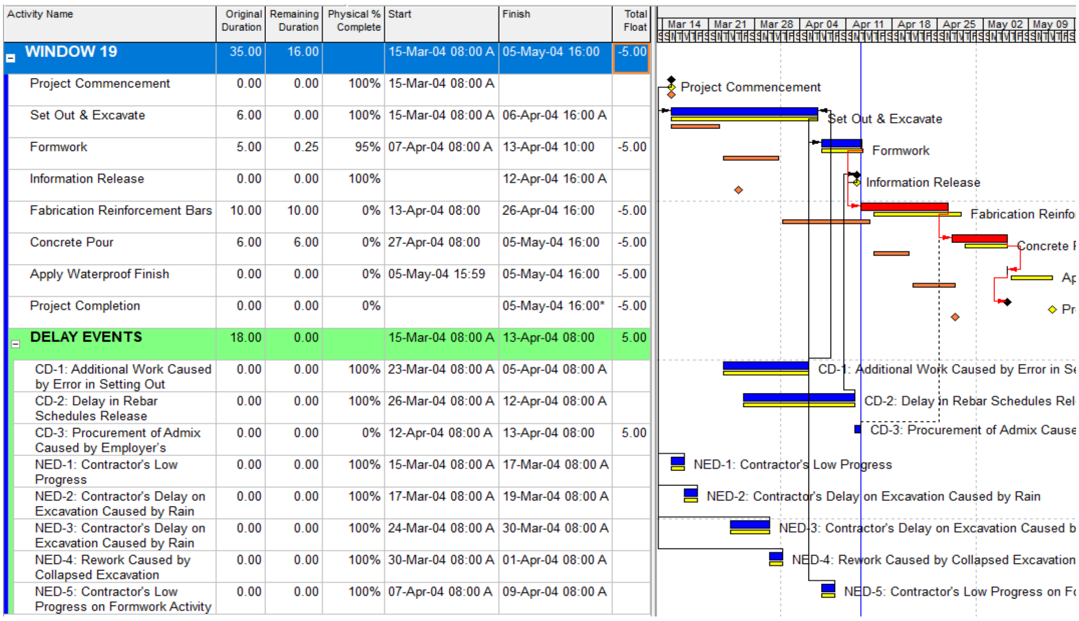
- The cumulative percentage of completed Formwork activity is reported by the Contractor as 95%. It is also reported that Fabrication Reinforcement Bars activity is ready to be started.
- Rebar schedules are released by the Employer.
- Employer instructed the Contractor to use Admix in the concrete instead of waterproof finish.

Since the cumulative progress of Formwork activity is 95% and planned duration of the activity was 5 days, the earned duration of the activity is 4.75 days. Hence, the estimated remaining duration is updated in the program as 0.25 days. According to as-planned program, Formwork activity had to be completed to start Fabrication Reinforcement Bars activity. Hence, finish to start with no lag time relationship was created between these activities in the as-planned program. However, as reported by the Contractor that Fabrication Reinforcement Bars activity is ready to be started even though Formwork activity is not fully completed. Due to that, to reflect as-built logic relationship between Formwork and Fabrication Reinforcement Bars activities is changed to finish to start with negative 0.25-day lag in the updated program for Window 19.

Information Release activity related to rebar schedules were planned to be released on 25-Mar-04 in the as-planned program. Finish to start with 2-day-lag relationship was created between Information Release and Fabrication Reinforcement Bars activities to reflect the lead time of procurement of rebars. However, the Contractor anticipated the procurement of rebars, and Fabrication Reinforcement Bars activity is ready to be started as stated in the daily progress records. Due to that, to reflect as-built logic, the relationship between Information Release and Fabrication Reinforcement Bars activities is changed to finish to start with no lag in the updated program for Window 19.

According to the Contract Document, errors or ambiguities in description of the work is an Employer's risk. The Employer changed the scope of waterproofing from waterproof finish to Admix in the concrete. This change is considered as part of Employer's risk as it is an ambiguity in the description of the work. Based on the changed scope, the Contractor needed to procure Admix material to start the Concrete Pour activity. As a result, a new compensable delay event is created in the updated program as CD-3: Procurement of Admix Caused by Employer's Instruction. The created compensable delay event is then linked with Concrete Pour activity, as Admix is required to perform this activity. Moreover, as a result of this change of waterproofing method, Apply Waterproof Finish activity is cancelled, and the duration of the activity is set to 0 days in the updated program. Even though cancellation of the Apply Waterproof Finish activity has resulted in acceleration in the program, the inclusion of Admix to Concrete Pour activity has increased the planned duration of Concrete Pour activity. To calculate the impact of inclusion of Admix to Concrete Pour duration, the daily progress records are analyzed. According to daily progress records, a total of 16 concrete pours were. Three pours were done at maximum for 2 subsequent days, which can be considered as a peak and an unimpacted period. As a result, the Contractor would be able to complete 16 pours minimum in 6 working days if it were to be able to maintain the same progress, that it achieved during peak time, throughout the duration of the activity. Therefore, the planned duration of the Concrete Pour is revised as 6 days to reflect the full impact of the change of scope from waterproof finish to the inclusion of Admix to the concrete in the updated program.

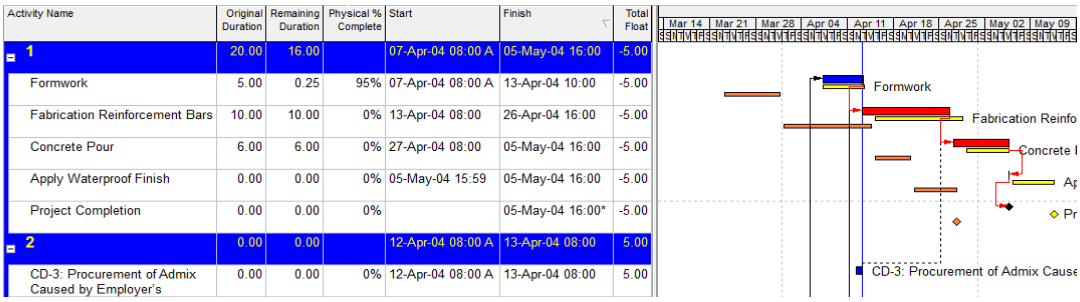
Figure 70 shows the updated program for Window 19. The program is accelerated and the project completion date is forecasted to be on 05-May-04, which means there is an acceleration of 7 calendar days compared to the previous window.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 19	35.00	16.00		15-Mar-04 08:00 A	05-May-04 16:00	-5.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.25	95%	07-Apr-04 08:00 A	13-Apr-04 10:00	-5.00
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 08:00	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
DELAY EVENTS	18.00	0.00		15-Mar-04 08:00 A	13-Apr-04 08:00	5.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	13-Apr-04 08:00	5.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	

Figure 70 Updated Program for Window 19

Figure 71 shows the float paths to the Project Completion milestone. Float Path 1 starts with Formwork activity that is included in the path from Set Out & Excavate to Project Completion. Even though Information Release activity is not shown on the float path view as the completed activities are not part of it, delay on the path from Information Release to Project Completion also has pushed the completion to 05-May-04 because Information Release activity was only completed by the Employer on 12-Apr-04 and successive activity Fabrication Reinforcement Bars is forecasted to start on 13-Apr-04. Hence, the start date of Fabrication Reinforcement Bars activity is not only driven by Formwork activity but also Information Release activity. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer's Instruction, did not cause any concurrent delay on contractual project completion date in this window as the total float of the activity that represents the delay event is 5 days.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	20.00	16.00		07-Apr-04 08:00 A	05-May-04 16:00	-5.00
Formwork	5.00	0.25	95%	07-Apr-04 08:00 A	13-Apr-04 10:00	-5.00
Fabrication Reinforcement Bars	10.00	10.00	0%	13-Apr-04 08:00	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
2	0.00	0.00		12-Apr-04 08:00 A	13-Apr-04 08:00	5.00
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	13-Apr-04 08:00	5.00

Figure 71 Float Paths of Updated Program for Window 19

The results of Window 19 of the delay analysis are shown in a summary format in Figure 69. There is 5-working-day and consequently a 7-calendar-day acceleration in this window. In summary, a 5-working-day acceleration is achieved through the cancellation of the Apply Waterproof Finish activity. However, as a result of a scope change to add Admix into the concrete, the planned duration of Concrete Pour activity is increased by 2 days. Furthermore, a 2-day acceleration is done by the Contractor in anticipation of the rebar procurement. Thus, the project completion is accelerated 5 working days compared to the previous window. The excusable delay that was reported in the previous windows on the path from Set Out & Excavate to Project Completion was a result of the concurrency of several non-excusable delay events and compensable delay event of CD-1: Additional Work Caused by Error in Setting Out. Since the activities in the path Set Out & Excavate are accelerated, it also reduced the impact of the compensable delay event of CD-1: Additional Work Caused by Error in Setting Out on the Project Completion milestone. Hence, the impact of excusable delay that was reported on the project completion date was also partially mitigated. A calculation of the impact of excusable delays on the project is carried out based on the difference between actual completion dates of Set Out & Excavate activity and CD-1: Additional Work Caused by Error in Setting Out, which is calculated as 2 working days. If non-excusable delays had not occurred on the Set Out & Excavate activity, the start date of the Formwork activity would have been 2 working days earlier than the actual start date, and thus the impact on Project Completion milestone would be 2 working days less. As the path from Set Out & Excavate to Project Completion has delayed the project completion to 05-May-04, the impact of excusable delays on this path is calculated by deducting 2 working days from 05-May-04, which results in 30-Apr-04 as 01-May-04, 02-May-04 and 03-May-04 are non-working days.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 19

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Formwork	Acceleration This Window	27-Apr-04	11-May-04	05-May-04	8	0	3	5				30-Apr-04						05-May-04							
Info. Release to Project Comp.	Information Release	Acceleration This Window	27-Apr-04	12-May-04	05-May-04	8	8	0	0										05-May-04							

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 72 Time Slice Windows Analysis Results for Window 19

3.2.1.20 Window 20 – From 13 April 2004 08:00 to 14 April 2004 08:00

As also shown in Figure 12, the daily progress records for 13-Apr-04 were as follows:

- Formwork activity is completed.
- Fabrication Reinforcement Bars activity is started. The cumulative percentage of completed activity is reported as 10%.
- A purchase order is placed for Admix. The expected delivery date is 22-Apr-04.

Since the cumulative progress of Fabrication Reinforcement Bars activity is 10% and planned duration of the activity was 10 days, the earned duration of the activity is 1 day. Hence, the estimated remaining duration is updated in the program as 9 days.

Figure 73 shows the updated program for Window 20. The project completion date is kept as 05-May-04, which means there is no critical delay compared to the previous window, and an 8-calendar-day delay compared to the as-planned program. Furthermore, the effect of compensable delay event CD-3: Procurement of Admix Caused by Employer's Instruction is continued.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 20	35.00	15.00		15-Mar-04 08:00 A	05-May-04 16:00	-5.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	9.00	10%	13-Apr-04 08:00 A	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
DELAY EVENTS	18.00	0.00		15-Mar-04 08:00 A	14-Apr-04 08:00	4.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	14-Apr-04 08:00	4.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	

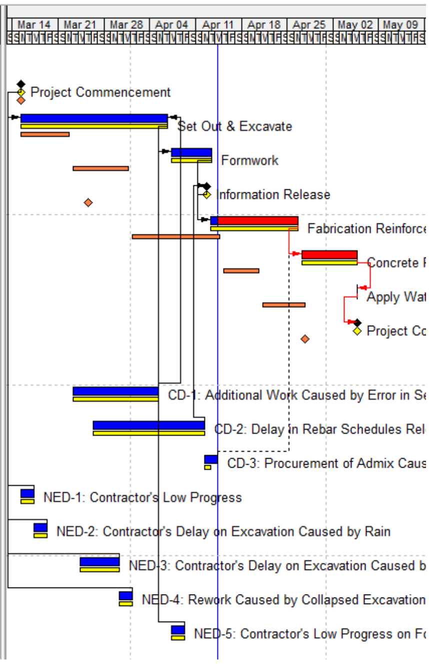
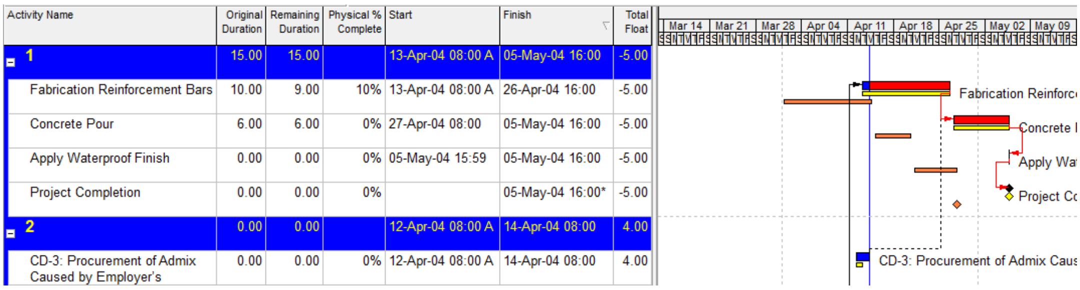


Figure 73 Updated Program for Window 20

Figure 74 shows the float paths to the Project Completion milestone on the updated program. Float Path 1, the most critical path of the project, starts with a Fabrication Reinforcement Bars activity that had a delayed start due to both a delay in the completion of Formwork and Information Release activities. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer's Instruction, did not cause any concurrent delay on the contractual project completion date as total float of the activity representing the delay event is 4 days.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	15.00	15.00		13-Apr-04 08:00 A	05-May-04 16:00	-5.00
Fabrication Reinforcement Bars	10.00	9.00	10%	13-Apr-04 08:00 A	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
2	0.00	0.00		12-Apr-04 08:00 A	14-Apr-04 08:00	4.00
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	14-Apr-04 08:00	4.00

Figure 74 Float Paths of Updated Program for Window 20

The results of Window 20 of the delay analysis are shown in a summary format in Figure 75. There is no critical delay on the critical path, which is the path from Set Out & Excavate to Project Completion in this window. Due to that, the overall delay on project completion was kept the same as the previous window as 8 calendar days. Furthermore, there is also an 8-day concurrent compensable delay on the path from Information Release to Project Completion.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 20																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	0	3	5				30-Apr-04					05-May-04								
Info. Release to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	8	0	0									05-May-04								

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 75 Time Slice Windows Analysis Results for Window 20

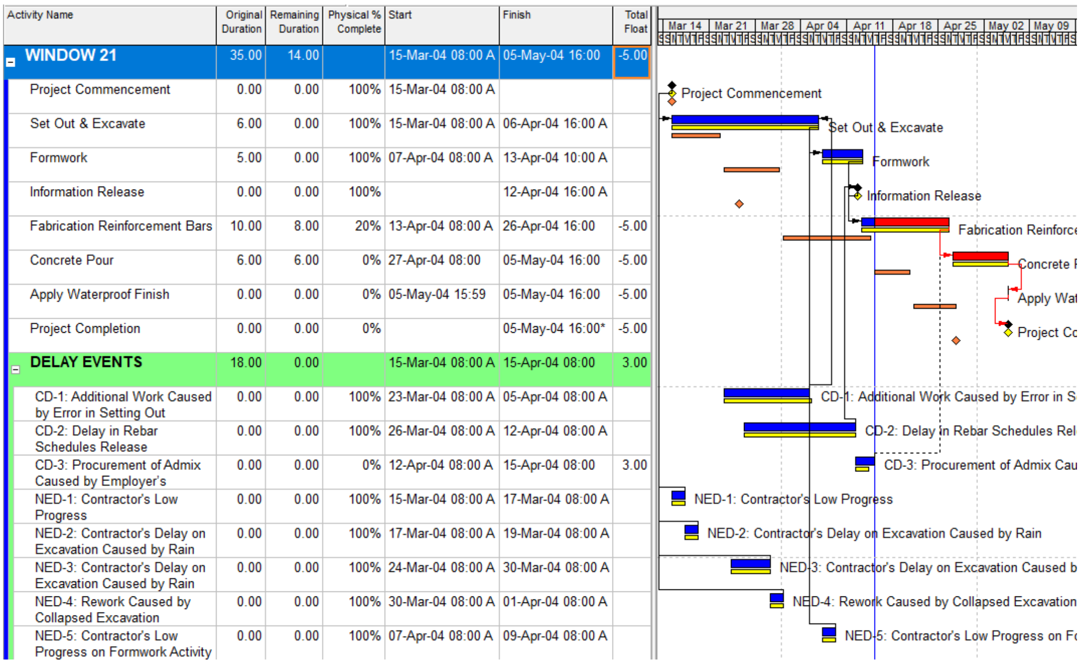
3.2.1.21 Window 21 – From 14 April 2004 08:00 to 15 April 2004 08:00

As also shown in Figure 12, the daily progress records for 14-Apr-04 were as follows:

- The cumulative percentage of completed Fabrication Reinforcement Bars activity is reported as 20%.
- Admix is not yet delivered to the site.

Since the cumulative progress of Fabrication Reinforcement Bars activity is 20% and planned duration of the activity was 10 days, the earned duration of the activity is 2 days. Hence, the estimated remaining duration is updated in the program as 8 days.

Figure 76 shows the updated program for Window 21. The project completion date is kept as 05-May-04, which means there is no critical delay compared to the previous window and an 8-calendar-day delay compared to the as-planned program. Furthermore, the effect of compensable delay event CD-3: Procurement of Admix Caused by Employer's Instruction is continued.

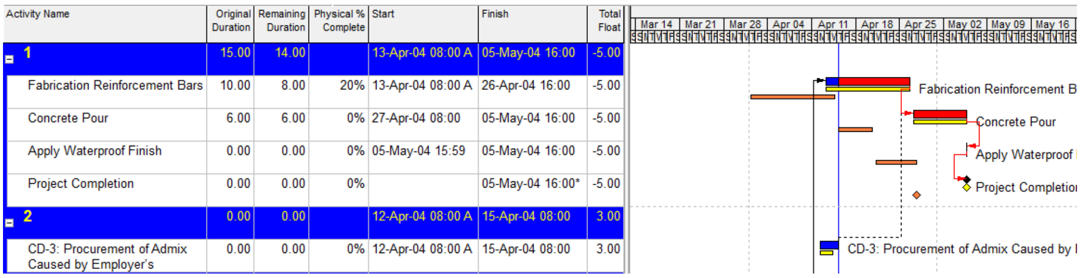


Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 21	35.00	14.00		15-Mar-04 08:00 A	05-May-04 16:00	-5.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	8.00	20%	13-Apr-04 08:00 A	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
DELAY EVENTS	18.00	0.00		15-Mar-04 08:00 A	15-Apr-04 08:00	3.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	15-Apr-04 08:00	3.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	

Figure 76 Updated Program for Window 21

Figure 77 shows the float paths to Project Completion milestone on the updated program. Float Path 1, the most critical path of the project, starts with Fabrication

Reinforcement Bars activity that had a delayed start due to both a delay in the completion of Formwork and Information Release activities. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer’s Instruction, did not cause any concurrent delay on the contractual project completion date as total float of the activity representing the delay event is 3 days.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	15.00	14.00		13-Apr-04 08:00 A	05-May-04 16:00	-5.00
Fabrication Reinforcement Bars	10.00	8.00	20%	13-Apr-04 08:00 A	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
2	0.00	0.00		12-Apr-04 08:00 A	15-Apr-04 08:00	3.00
CD-3: Procurement of Admix Caused by Employer’s	0.00	0.00	0%	12-Apr-04 08:00 A	15-Apr-04 08:00	3.00

Figure 77 Float Paths of Updated Program for Window 21

The results of Window 21 of the delay analysis are shown in a summary format in Figure 78. There is no critical delay on the critical path, which is the path from Set Out & Excavate to Project Completion in this window. Due to that, the overall delay on project completion is kept the same as the previous window as 8 calendar days. Furthermore, there is also an 8-day concurrent compensable delay on the path from Information Release to Project Completion.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 21

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays Tot.	CD	ED	NED	27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
Set Out & Exc. to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	0	3	5						30-Apr-04				05-May-04							
Info. Release to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	8	0	0										05-May-04							

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 78 Time Slice Windows Analysis Results for Window 21

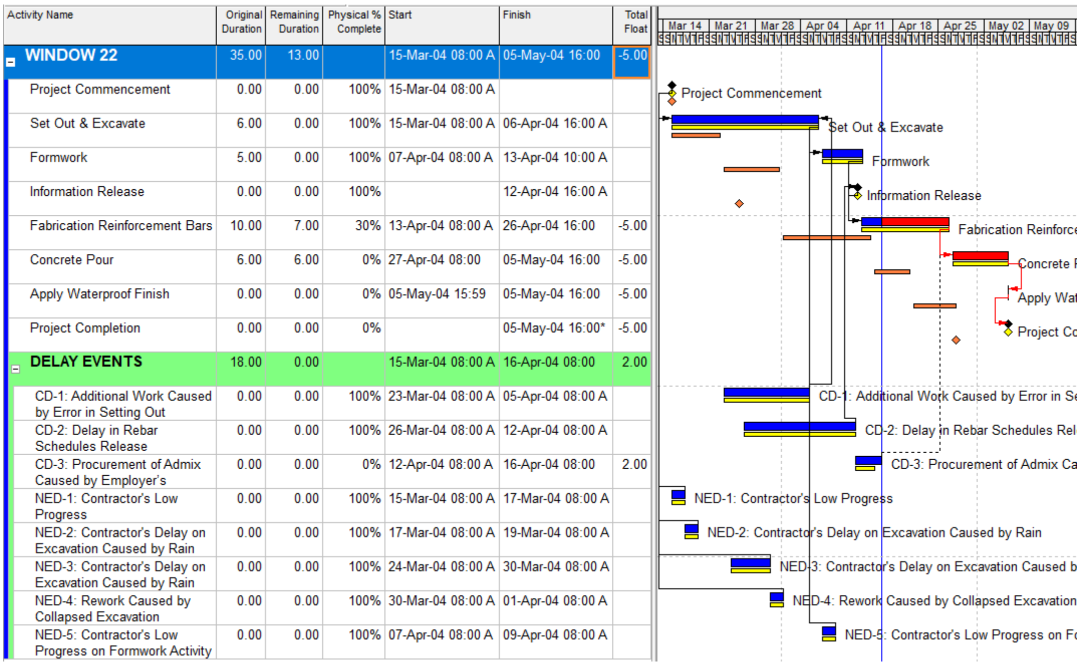
3.2.1.22 Window 22 – From 15 April 2004 08:00 to 16 April 2004 08:00

As also shown in Figure 12, the daily progress records for 15-Apr-04 were as follows:

- The cumulative progress of Fabrication Rebars activity is reported as 30%.
- Admix has not yet been delivered to the site.

Since the cumulative progress of Fabrication Reinforcement Bars activity is 30% and the planned duration of the activity was 10 days, the earned duration of the activity is 3 days. Thus, the estimated remaining duration is updated in the program as 7 days.

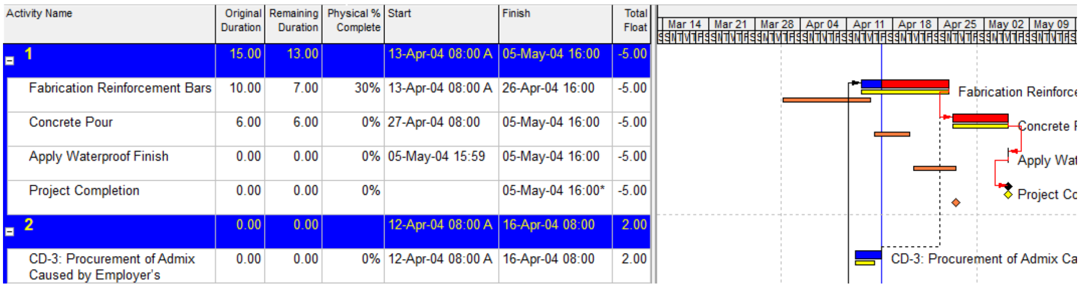
Figure 79 shows the updated program for Window 22. The project completion date is kept as 05-May-04, which means there is no critical delay compared to the previous window, and an 8-calendar-day delay compared to the as-planned program. Furthermore, the effect of compensable delay event CD-3: Procurement of Admix Caused by Employer's Instruction is continued.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 22	35.00	13.00		15-Mar-04 08:00 A	05-May-04 16:00	-5.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	7.00	30%	13-Apr-04 08:00 A	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
DELAY EVENTS	18.00	0.00		15-Mar-04 08:00 A	16-Apr-04 08:00	2.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	16-Apr-04 08:00	2.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	

Figure 79 Updated Program for Window 22

Figure 80 shows the float paths to the Project Completion milestone on the updated program. Float Path 1, the most critical path of the project, starts with the Fabrication Reinforcement Bars activity that had a delayed start due to both delay in the completion of Formwork and Information Release activities. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer's Instruction, did not cause any concurrent delay on the contractual project completion date, as total float of the activity representing the delay event is 2 days.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	15.00	13.00		13-Apr-04 08:00 A	05-May-04 16:00	-5.00
Fabrication Reinforcement Bars	10.00	7.00	30%	13-Apr-04 08:00 A	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
2	0.00	0.00		12-Apr-04 08:00 A	16-Apr-04 08:00	2.00
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	16-Apr-04 08:00	2.00

Figure 80 Float Paths of Updated Program for Window 22

The results of Window 22 of the delay analysis are shown in a summary format in Figure 81. There is no critical delay on the critical path, which is the path from Set Out & Excavate to Project Completion in this window. Hence, the overall delay on project completion is kept the same as previous window as 8 calendar days. There is also a concurrent compensable delay of 8 days on the path from Information Release to Project Completion.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 22

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	0	3	5					30-Apr-04					05-May-04							
Info. Release to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	8	0	0										05-May-04							

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 81 Time Slice Windows Analysis Results for Window 22

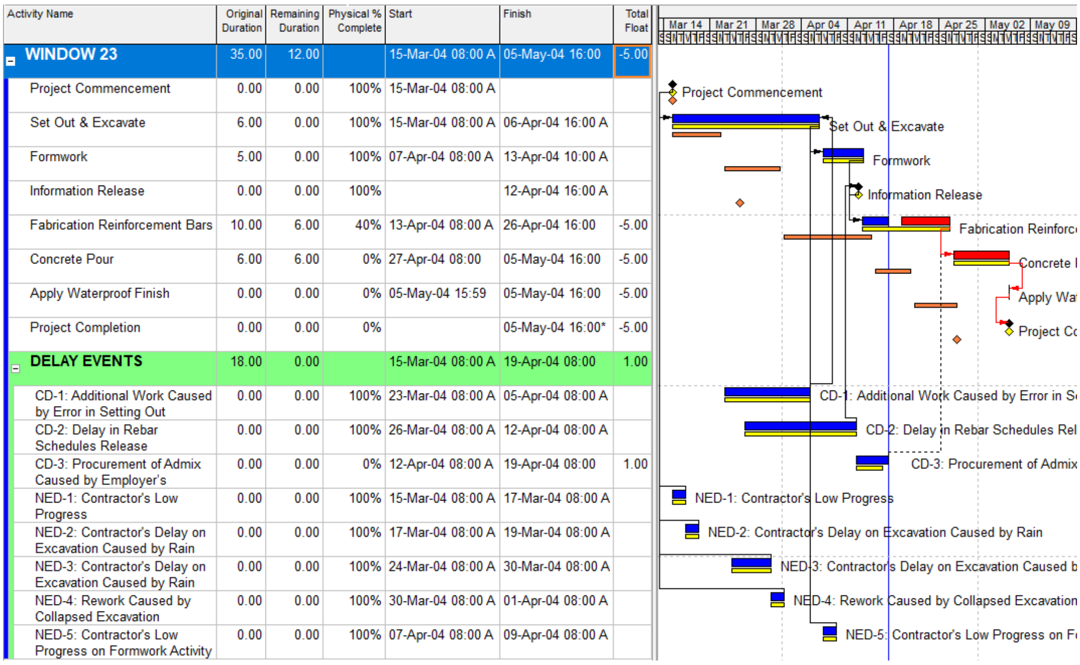
3.2.1.23 Window 23 – From 16 April 2004 08:00 to 17 April 2004 08:00

As also shown in Figure 12, the daily progress records for 16-Apr-04 were as follows:

- The cumulative progress of Fabrication Rebars activity is reported as 40%.
- Admix is not yet delivered to the site.

Since the cumulative progress of Fabrication Reinforcement Bars activity is 40% and planned duration of the activity was 10 days, the earned duration of the activity is 4 days. Hence, the estimated remaining duration is updated in the program as 6 days.

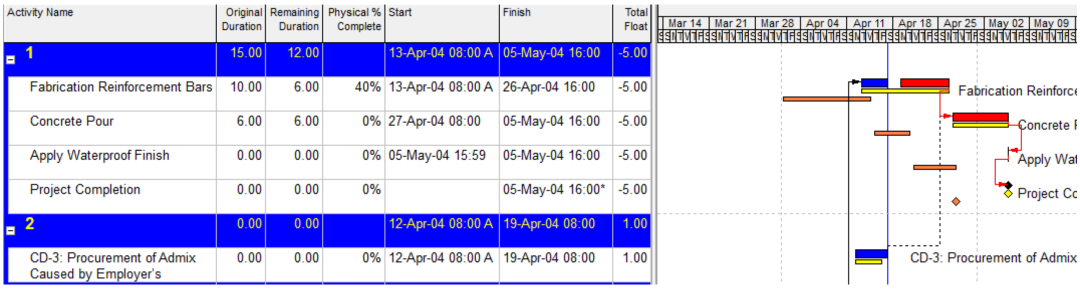
Figure 82 shows the updated program for Window 23. The project completion date is kept as 05-May-04, which means there is no critical delay compared to the previous window, and a delay of 8 calendar days compared to the as-planned program. Furthermore, the effect of compensable delay event CD-3: Procurement of Admix Caused by Employer's Instruction is continued.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 23	35.00	12.00		15-Mar-04 08:00 A	05-May-04 16:00	-5.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	6.00	40%	13-Apr-04 08:00 A	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
DELAY EVENTS	18.00	0.00		15-Mar-04 08:00 A	19-Apr-04 08:00	1.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	19-Apr-04 08:00	1.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	

Figure 82 Updated Program for Window 23

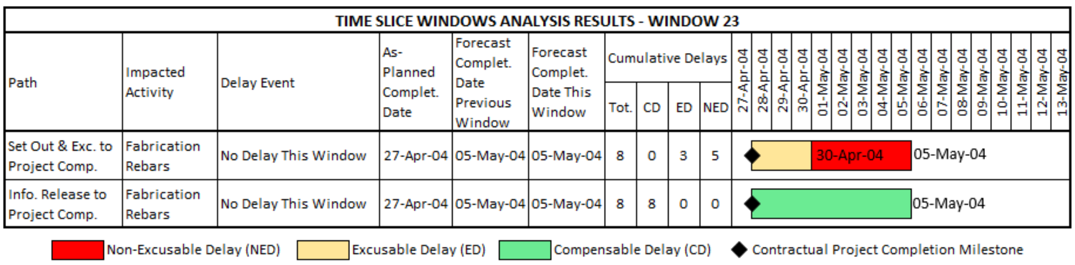
Figure 83 shows the float paths to Project Completion milestone on the updated program. Float Path 1, the most critical path of the project, starts with Fabrication Reinforcement Bars activity that had a delayed start due to both a delay in the completion of Formwork and Information Release activities. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer's Instruction, did not cause any concurrent delay on contractual project completion date as total float of the activity representing the delay event is 1 day.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	15.00	12.00		13-Apr-04 08:00 A	05-May-04 16:00	-5.00
Fabrication Reinforcement Bars	10.00	6.00	40%	13-Apr-04 08:00 A	26-Apr-04 16:00	-5.00
Concrete Pour	6.00	6.00	0%	27-Apr-04 08:00	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
2	0.00	0.00		12-Apr-04 08:00 A	19-Apr-04 08:00	1.00
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	19-Apr-04 08:00	1.00

Figure 83 Float Paths of Updated Program for Window 23

The results of Window 23 of the delay analysis are shown in a summary format in Figure 84. There is no critical delay on the critical path, which is the path from Set Out & Excavate to Project Completion in this window. Therefore, the overall delay on project completion from the previous window is maintained as 8 calendar days. Furthermore, there is also a concurrent compensable delay of 8 days on the path from Information Release to Project Completion.



TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 23

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays Tot.	CD	ED	NED
Set Out & Exc. to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	0	3	5
Info. Release to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	8	0	0

Figure 84 Time Slice Windows Analysis Results for Window 23

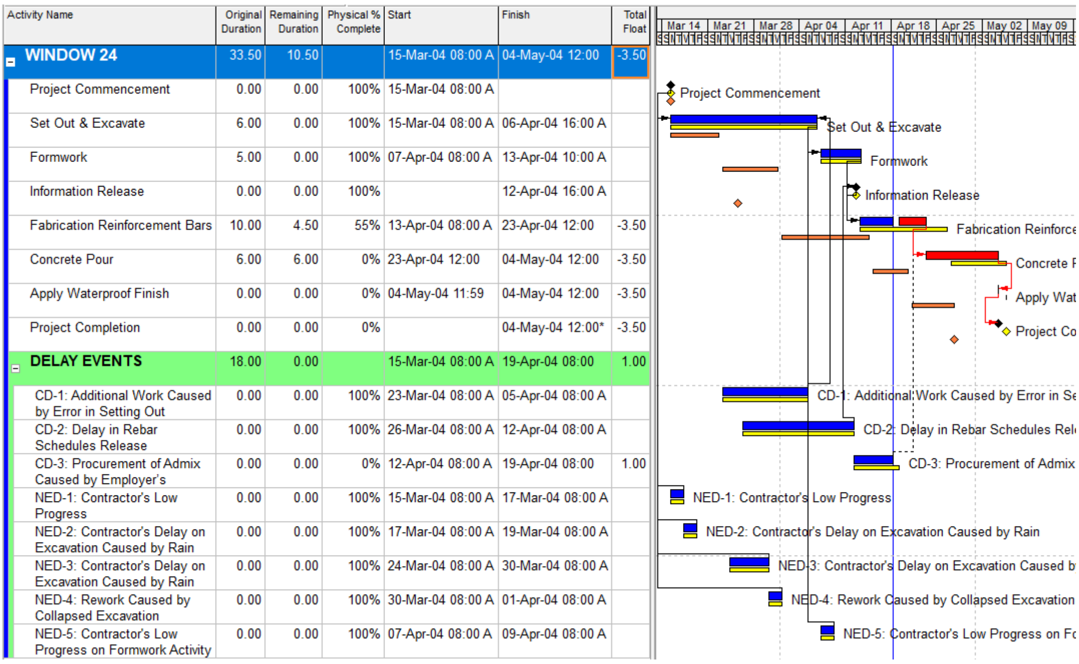
3.2.1.24 Window 24 – From 17 April 2004 08:00 to 18 April 2004 08:00

Even though 17-Apr-04 was a non-working day, the Contractor has worked to accelerate the program. As also shown in Figure 12, the daily progress records for 17-Apr-04 were as follows:

- The cumulative progress of Fabrication Rebars activity is reported as 55%.

Since the cumulative progress of Fabrication Reinforcement Bars activity is 55% and the planned duration of the activity was 10 days, the earned duration of the activity is 5.5 days. Hence, the remaining duration is updated in the program as 4.5 days.

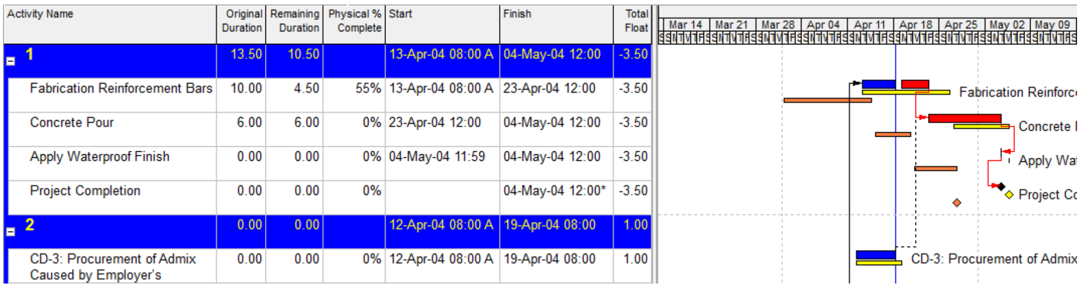
Figure 85 shows the updated program for Window 24. The project completion date is changed to an earlier date because work was done on a non-working day on Fabrication Reinforcement Bars, as 04-May-04. Hence, there is an acceleration of 1 calendar day compared to the previous window, and a delay of 7 calendar days compared to the as-planned program. Furthermore, the effect of compensable delay event CD-3: Procurement of Admix Caused by Employer's Instruction is continued.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 24	33.50	10.50		15-Mar-04 08:00 A	04-May-04 12:00	-3.50
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	4.50	55%	13-Apr-04 08:00 A	23-Apr-04 12:00	-3.50
Concrete Pour	6.00	6.00	0%	23-Apr-04 12:00	04-May-04 12:00	-3.50
Apply Waterproof Finish	0.00	0.00	0%	04-May-04 11:59	04-May-04 12:00	-3.50
Project Completion	0.00	0.00	0%		04-May-04 12:00*	-3.50
DELAY EVENTS	18.00	0.00		15-Mar-04 08:00 A	19-Apr-04 08:00	1.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	19-Apr-04 08:00	1.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	

Figure 85 Updated Program for Window 24

Figure 86 shows the float paths to the Project Completion milestone on the updated program. Float Path 1, the most critical path of the project, starts with Fabrication Reinforcement Bars activity that had a delayed start due to a delay in both the completion of Formwork and Information Release activities. Fabrication Reinforcement Bars activity is accelerated by 1 calendar day compared to the previous window. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer's Instruction, did not cause any concurrent delay on the contractual project completion date, as the total float of the activity representing the delay event is 1 day.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	13.50	10.50		13-Apr-04 08:00 A	04-May-04 12:00	-3.50
Fabrication Reinforcement Bars	10.00	4.50	55%	13-Apr-04 08:00 A	23-Apr-04 12:00	-3.50
Concrete Pour	6.00	6.00	0%	23-Apr-04 12:00	04-May-04 12:00	-3.50
Apply Waterproof Finish	0.00	0.00	0%	04-May-04 11:59	04-May-04 12:00	-3.50
Project Completion	0.00	0.00	0%		04-May-04 12:00*	-3.50
2	0.00	0.00		12-Apr-04 08:00 A	19-Apr-04 08:00	1.00
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	19-Apr-04 08:00	1.00

Figure 86 Float Paths of Updated Program for Window 24

The results of Window 24 of the delay analysis are shown in a summary format in Figure 87. Both paths, which are from Set Out & Excavate to Project Completion and from Information Release to Project Completion, contain Fabrication Reinforcement Bars activity. Hence, as a result of the acceleration in Fabrication Reinforcement Bars activity by one day, the delays on both of these paths are reduced by one day. Accordingly, the critical delay is reduced to 7 calendar days in this window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 24																											
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Fabrication Rebars	Acceleration This Window	27-Apr-04	05-May-04	04-May-04	7	0	2	5	◆			29-Apr-04					04-May-04								
Info. Release to Project Comp.	Fabrication Rebars	Acceleration This Window	27-Apr-04	05-May-04	04-May-04	7	7	0	0	◆								04-May-04								

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 87 Time Slice Windows Analysis Results for Window 24

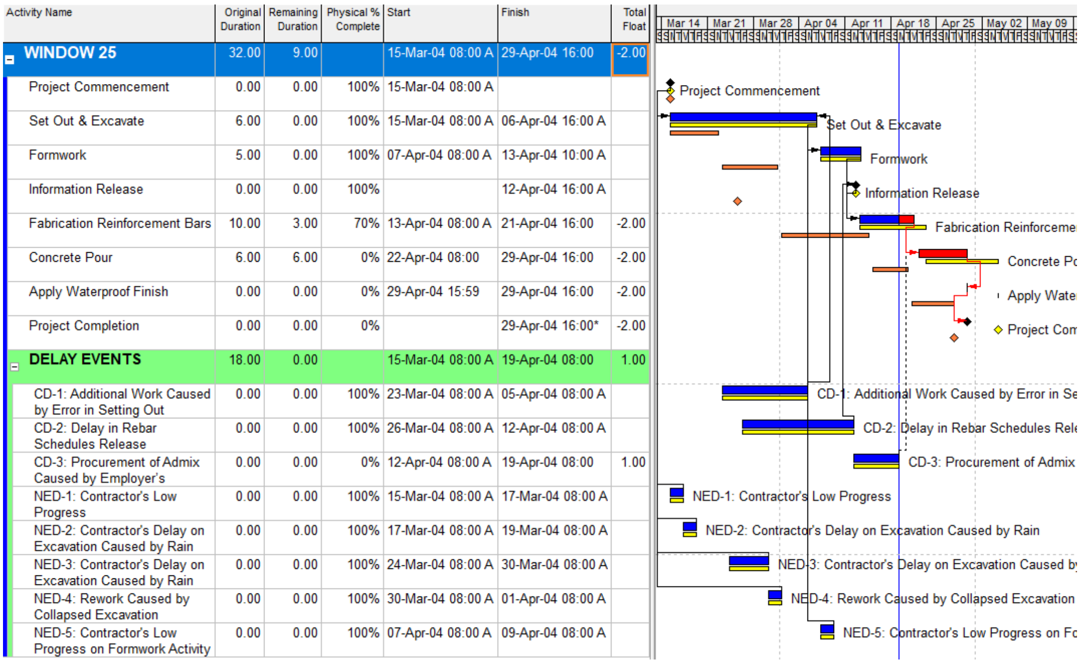
3.2.1.25 Window 25 – From 18 April 2004 08:00 to 19 April 2004 08:00

Even though 18-Apr-04 was non-working day, the Contractor has worked to accelerate the program. As also shown in Figure 12, the daily progress records for 18-Apr-04 were as follows:

- The cumulative percentage of completed Fabrication Reinforcement Bars activity is reported as 70%.
- Admix has not yet been delivered to the site.

Since the cumulative progress of Fabrication Reinforcement Bars activity is 70% and the planned duration of the activity was 10 days, the earned duration of the activity is 7 days. Hence, the estimated remaining duration is updated in the program as 3 days.

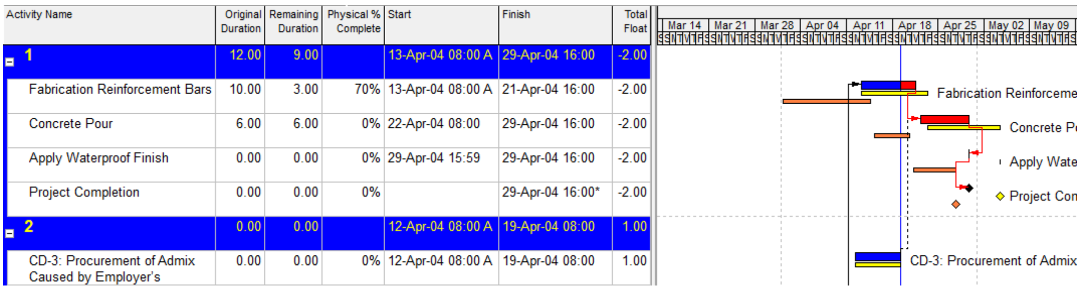
Figure 88 shows the updated program for Window 25. The project completion date is brought to an earlier date due to work being done on a non-working day as well as the high progress achieved on Fabrication Reinforcement Bars, as 29-Apr-04. This results in a 2-working-day and consequently a 5-calendar-day acceleration compared to the previous window, since 01-May-04, 02-May-04, and 03-May-04 were non-working days. Furthermore, the effect of compensable delay event CD-3: Procurement of Admix Caused by Employer's Instruction is continued.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 25	32.00	9.00		15-Mar-04 08:00 A	29-Apr-04 16:00	-2.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	3.00	70%	13-Apr-04 08:00 A	21-Apr-04 16:00	-2.00
Concrete Pour	6.00	6.00	0%	22-Apr-04 08:00	29-Apr-04 16:00	-2.00
Apply Waterproof Finish	0.00	0.00	0%	29-Apr-04 15:59	29-Apr-04 16:00	-2.00
Project Completion	0.00	0.00	0%		29-Apr-04 16:00*	-2.00
DELAY EVENTS	18.00	0.00		15-Mar-04 08:00 A	19-Apr-04 08:00	1.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	19-Apr-04 08:00	1.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	

Figure 88 Updated Program for Window 25

Figure 89 shows the float paths to Project Completion milestone on the updated program. Float Path 1 starts with Fabrication Rebars activity that had a delayed start due to delays in both the completion of Formwork and Information Release activities. Fabrication Rebars activity is accelerated by 2 working days, and the finish date of the activity is brought from 23-Apr-04 to 21-Apr-04, compared to the previous window. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer's Instruction, did not cause any concurrent delay on the contractual project completion date as the total float of the delay event activity is 1 day.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	12.00	9.00		13-Apr-04 08:00 A	29-Apr-04 16:00	-2.00
Fabrication Reinforcement Bars	10.00	3.00	70%	13-Apr-04 08:00 A	21-Apr-04 16:00	-2.00
Concrete Pour	6.00	6.00	0%	22-Apr-04 08:00	29-Apr-04 16:00	-2.00
Apply Waterproof Finish	0.00	0.00	0%	29-Apr-04 15:59	29-Apr-04 16:00	-2.00
Project Completion	0.00	0.00	0%		29-Apr-04 16:00*	-2.00
2	0.00	0.00		12-Apr-04 08:00 A	19-Apr-04 08:00	1.00
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	19-Apr-04 08:00	1.00

Figure 89 Float Paths of Updated Program for Window 25

The results of Window 25 of the delay analysis are shown in a summary format in Figure 90. Both paths, which are from Set Out & Excavate to Project Completion and from Information Release to Project Completion, contain Fabrication Reinforcement Bars activity. Hence, as a result of acceleration in Fabrication Reinforcement Bars activity by two working days, the delays on both of these paths are reduced by two working days. Accordingly, the critical delay is reduced to 2 calendar days in this window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 25

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Fabrication Rebars	Acceleration This Window	27-Apr-04	04-May-04	29-Apr-04	2	0	0	2				29-Apr-04													
Info. Release to Project Comp.	Fabrication Rebars	Acceleration This Window	27-Apr-04	04-May-04	29-Apr-04	2	2	0	0				29-Apr-04													

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 90 Time Slice Windows Analysis Results for Window 25

3.2.1.26 Window 26 – From 19 April 2004 08:00 to 20 April 2004 08:00

As also shown in Figure 12, the daily progress records for 19-Apr-04 were as follows:

- The cumulative percentage of completed Fabrication Reinforcement Bars activity is reported as 80%.
- Admix has not yet been delivered to the site.

Since the cumulative progress of Fabrication Reinforcement Bars activity is 80% and the planned duration of the activity was 10 days, the earned duration of the activity is 8 days. Hence, the estimated remaining duration is updated in the program as 2 days.

Figure 91 shows the updated program for Window 26. The project completion date is kept as 29-Apr-04, which means there is no critical delay compared to the previous window and a 2-calendar-day delay compared to the as-planned program. Furthermore, the effect of compensable delay event CD-3: Procurement of Admix Caused by Employer’s Instruction is continued.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 26	32.00	8.00		15-Mar-04 08:00 A	29-Apr-04 16:00	-2.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	2.00	80%	13-Apr-04 08:00 A	21-Apr-04 16:00	-2.00
Concrete Pour	6.00	6.00	0%	22-Apr-04 08:00	29-Apr-04 16:00	-2.00
Apply Waterproof Finish	0.00	0.00	0%	29-Apr-04 15:59	29-Apr-04 16:00	-2.00
Project Completion	0.00	0.00	0%		29-Apr-04 16:00*	-2.00
DELAY EVENTS	18.00	0.00		15-Mar-04 08:00 A	20-Apr-04 08:00	0.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	20-Apr-04 08:00	0.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	

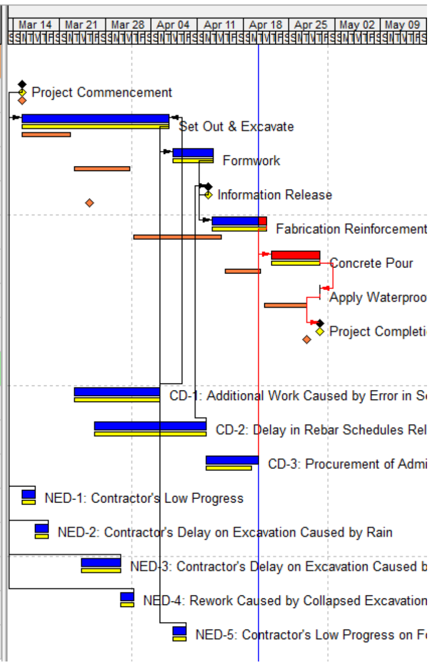
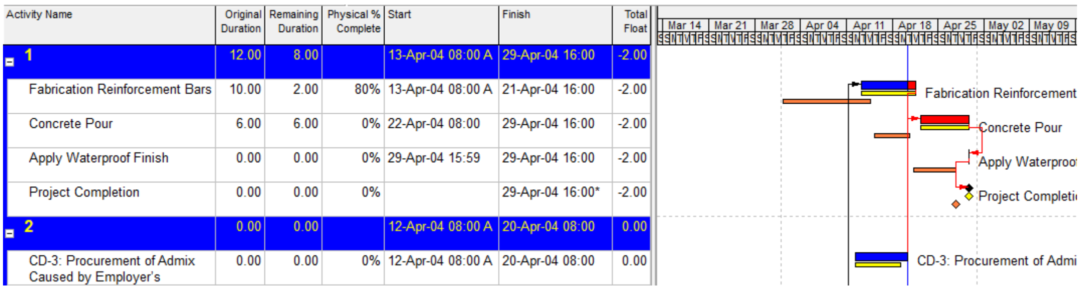


Figure 91 Updated Program for Window 26

Figure 92 shows the float paths to Project Completion milestone on the updated program. Float Path 1, the most critical path of the project, starts with Fabrication Reinforcement Bars activity that had a delayed start due to a delay in both the completion of Formwork and Information Release activities. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer’s Instruction, did not cause any concurrent delay on contractual project completion date as the total float of the activity representing the delay event is 0-day.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	12.00	8.00		13-Apr-04 08:00 A	29-Apr-04 16:00	-2.00
Fabrication Reinforcement Bars	10.00	2.00	80%	13-Apr-04 08:00 A	21-Apr-04 16:00	-2.00
Concrete Pour	6.00	6.00	0%	22-Apr-04 08:00	29-Apr-04 16:00	-2.00
Apply Waterproof Finish	0.00	0.00	0%	29-Apr-04 15:59	29-Apr-04 16:00	-2.00
Project Completion	0.00	0.00	0%		29-Apr-04 16:00*	-2.00
2	0.00	0.00		12-Apr-04 08:00 A	20-Apr-04 08:00	0.00
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	20-Apr-04 08:00	0.00

Figure 92 Float Paths of Updated Program for Window 26

The results of Window 26 of the delay analysis are shown in a summary format in Figure 93. There is no critical delay on critical path, which is the path from Set Out & Excavate to Project Completion in this window. Thus, the overall delay on the project completion is kept the same as the previous window as 2 calendar days. Furthermore, there is also a 2-day concurrent compensable delay on the path from Information Release to Project Completion.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 26

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	29-Apr-04	29-Apr-04	2	0	0	2			29-Apr-04														
Info. Release to Project Comp.	Fabrication Rebars	No Delay This Window	27-Apr-04	29-Apr-04	29-Apr-04	2	2	0	0			29-Apr-04														

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 93 Time Slice Windows Analysis Results for Window 26

3.2.1.27 Window 27 – From 20 April 2004 08:00 to 21 April 2004 08:00

As also shown in Figure 12, the daily progress records for 20-Apr-04 were as follows:

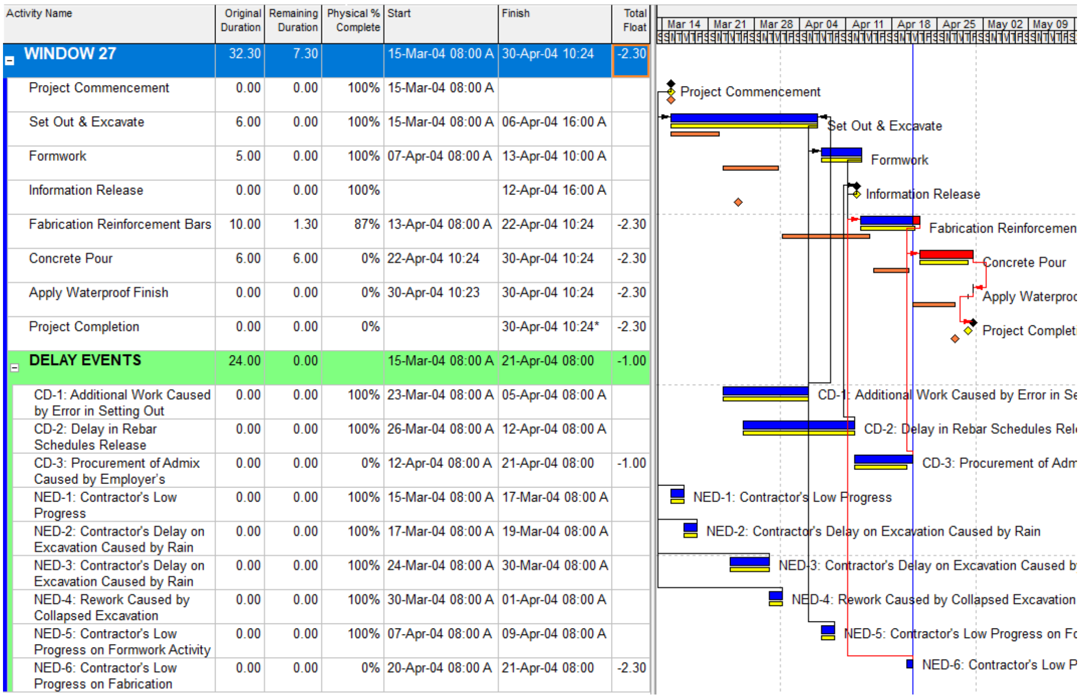
- The cumulative percentage of completed Fabrication Reinforcement Bars activity is reported as 87%.

- Admix is not yet delivered to the site.

Since the cumulative progress of Fabrication Reinforcement Bars activity is 87% and the planned duration of the activity was 10 days, the earned duration of the activity is 8.7 days. Hence, the estimated remaining duration is updated in the program as 1.3 days. The planned daily progress of the activity was 10% and the achieved daily progress was 7%. Due to that, there is a Contractor delay caused by the low progress on the Fabrication Reinforcement Bars activity in this window. An activity representing the delay event is created as NED-6: Contractor's Low Progress on Fabrication Reinforcement Bars.

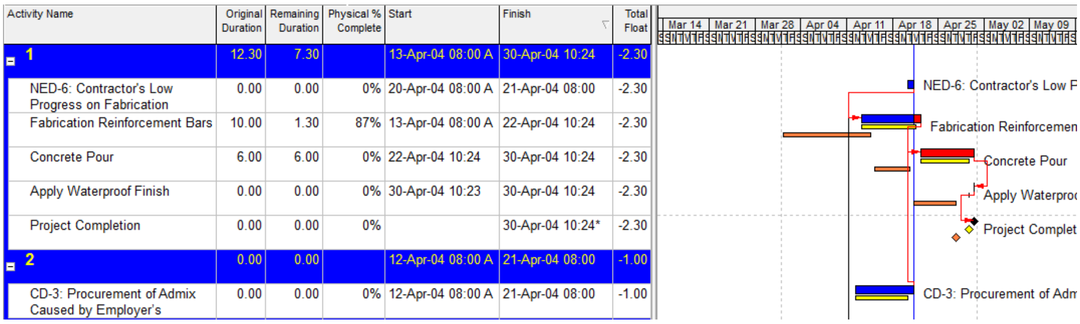
Figure 94 shows the updated program for Window 27. The project completion date is shifted to 30-Apr-04, which means there is a delay of 1 calendar day compared to the previous window and a delay of 3 calendar days compared to the as-planned program. The critical delay occurred due to non-excusable delay event NED-6: Contractor’s Low Progress on Fabrication Reinforcement Bars. Furthermore, the effect of compensable delay event CD-3: Procurement of Admix Caused by Employer’s Instruction is continued.

Figure 95 shows the float paths to the Project Completion milestone on the updated program. Float Path 1, which contains NED-6: Contractor’s Low Progress on Fabrication Reinforcement Bars, delays the project completion milestone date to 30-Apr-04, which means a 3-calendar-day delay compared to the as-planned program. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer’s Instruction, also cause a concurrent delay on the contractual project completion date as the total float of the activity representing the delay event is -1 day, which pushes the Project Completion milestone to 28-Apr-04.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 27	32.30	7.30		15-Mar-04 08:00 A	30-Apr-04 10:24	-2.30
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	1.30	87%	13-Apr-04 08:00 A	22-Apr-04 10:24	-2.30
Concrete Pour	6.00	6.00	0%	22-Apr-04 10:24	30-Apr-04 10:24	-2.30
Apply Waterproof Finish	0.00	0.00	0%	30-Apr-04 10:23	30-Apr-04 10:24	-2.30
Project Completion	0.00	0.00	0%		30-Apr-04 10:24*	-2.30
DELAY EVENTS	24.00	0.00		15-Mar-04 08:00 A	21-Apr-04 08:00	-1.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	21-Apr-04 08:00	-1.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	0%	20-Apr-04 08:00 A	21-Apr-04 08:00	-2.30

Figure 94 Updated Program for Window 27



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	12.30	7.30		13-Apr-04 08:00 A	30-Apr-04 10:24	-2.30
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	0%	20-Apr-04 08:00 A	21-Apr-04 08:00	-2.30
Fabrication Reinforcement Bars	10.00	1.30	87%	13-Apr-04 08:00 A	22-Apr-04 10:24	-2.30
Concrete Pour	6.00	6.00	0%	22-Apr-04 10:24	30-Apr-04 10:24	-2.30
Apply Waterproof Finish	0.00	0.00	0%	30-Apr-04 10:23	30-Apr-04 10:24	-2.30
Project Completion	0.00	0.00	0%		30-Apr-04 10:24*	-2.30
2	0.00	0.00		12-Apr-04 08:00 A	21-Apr-04 08:00	-1.00
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	21-Apr-04 08:00	-1.00

Figure 95 Float Paths of Updated Program for Window 27

The results of Window 27 of the delay analysis are shown in a summary format in Figure 96. There is a 1-day critical delay on the Project Completion milestone caused by a non-excusable delay event that affected the both the path from Set Out & Excavate to Project Completion and from Information Release to Project Completion. In addition to these, there is also a 1-day concurrent compensable delay related to the procurement of Admix on the path from Employer's Instruction to Project Completion.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 27																											
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Fabrication Rebars	NED-6: Contractor Low Progress on Rebar Work	27-Apr-04	29-Apr-04	30-Apr-04	3	0	0	3					30-Apr-04												
Info. Release to Project Comp.	Fabrication Rebars	NED-6: Contractor Low Progress on Rebar Work	27-Apr-04	29-Apr-04	30-Apr-04	3	2	0	1					30-Apr-04												
Employer Inst. to Project Comp.	Concrete Pour	CD-3: Procurement of Admix	27-Apr-04	27-Apr-04	28-Apr-04	1	1	0	0			28-Apr-04														

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 96 Time Slice Windows Analysis Results for Window 27

3.2.1.28 Window 28 – From 21 April 2004 08:00 to 22 April 2004 08:00

As also shown in Figure 12, the daily progress records for 21-Apr-04 were as follows:

- Cumulative percentage of completed Fabrication Rebars activity is reported as 95%.
- Admix is not yet delivered to site.

Since the cumulative progress of Fabrication Reinforcement Bars activity is 95%, the estimated remaining duration is updated in the program as 0.5 days. The planned daily progress of the activity was 10% and the achieved daily progress was 8%. Due to that, NED-6: Contractor's Low Progress on Fabrication Rebars delay event continued in this window.

Figure 97 shows the updated program for Window 28. The project completion date is kept as 30-Apr-04, which means that there is no critical delay compared to the previous window and a 3-calendar-day delay compared to the as-planned program. Furthermore, the effect of compensable delay event CD-3: Procurement of Admix Caused by Employer's Instruction is continued.

Figure 98 shows the float paths to Project Completion milestone. Float Path 1, which contains NED-6: Contractor's Low Progress on Fabrication Reinforcement Bars, delays the Project Completion milestone date to 30-Apr-04, which means a

3-calendar-day delay compared to the as-planned program. Float Path 2, which contains CD-3: Procurement of Admix Caused by Employer's Instruction, also cause a concurrent delay on the project completion date as the total float of the activity representing the delay event is -2 days, which pushes the project completion milestone to 29-Apr-04.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 28	32.50	6.50		15-Mar-04 08:00 A	30-Apr-04 12:00	-2.50
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	0.50	95%	13-Apr-04 08:00 A	22-Apr-04 12:00	-2.50
Concrete Pour	6.00	6.00	0%	22-Apr-04 12:00	30-Apr-04 12:00	-2.50
Apply Waterproof Finish	0.00	0.00	0%	30-Apr-04 11:59	30-Apr-04 12:00	-2.50
Project Completion	0.00	0.00	0%		30-Apr-04 12:00*	-2.50
DELAY EVENTS	24.00	0.00		15-Mar-04 08:00 A	22-Apr-04 08:00	-2.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	22-Apr-04 08:00	-2.00
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	0%	20-Apr-04 08:00 A	22-Apr-04 08:00	-2.50

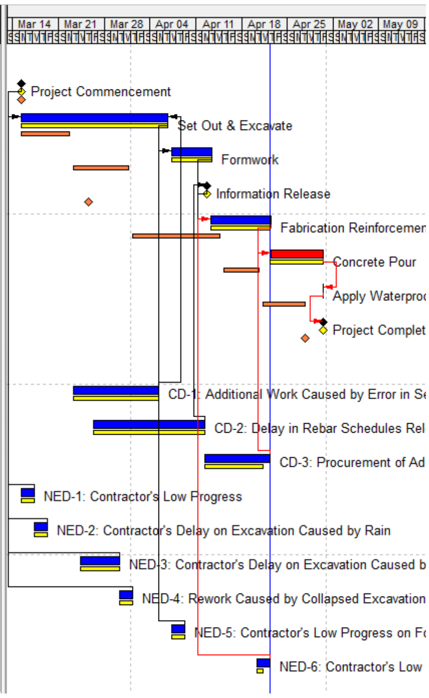


Figure 97 Updated Program for Window 28

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	12.50	6.50		13-Apr-04 08:00 A	30-Apr-04 12:00	-2.50
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	0%	20-Apr-04 08:00 A	22-Apr-04 08:00	-2.50
Fabrication Reinforcement Bars	10.00	0.50	95%	13-Apr-04 08:00 A	22-Apr-04 12:00	-2.50
Concrete Pour	6.00	6.00	0%	22-Apr-04 12:00	30-Apr-04 12:00	-2.50
Apply Waterproof Finish	0.00	0.00	0%	30-Apr-04 11:59	30-Apr-04 12:00	-2.50
Project Completion	0.00	0.00	0%		30-Apr-04 12:00*	-2.50
2	0.00	0.00		12-Apr-04 08:00 A	22-Apr-04 08:00	-2.00
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	0%	12-Apr-04 08:00 A	22-Apr-04 08:00	-2.00

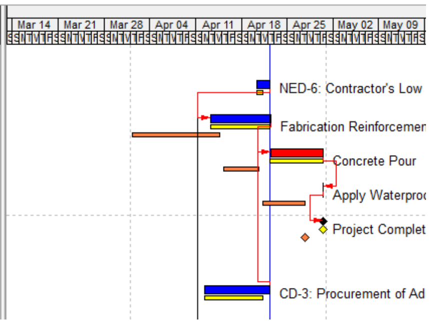


Figure 98 Float Paths of Updated Program for Window 28

The results of Window 28 of the delay analysis are shown in a summary format in Figure 99. There is no change on the project completion date compared to the previous window which had 3 calendar days delay. Furthermore, there is also a 2-day concurrent compensable delay related to the procurement of Admix on the path from the Employer's Instruction to Project Completion.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 28																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Fabrication Rebars	NED-6: Contractor Low Progress on Rebar Work	27-Apr-04	30-Apr-04	30-Apr-04	3	0	0	3					30-Apr-04												
Info. Release to Project Comp.	Fabrication Rebars	NED-6: Contractor Low Progress on Rebar Work	27-Apr-04	30-Apr-04	30-Apr-04	3	2	0	1					30-Apr-04												
Employer Inst. to Project Comp.	Concrete Pour	CD-3: Procurement of Admix	27-Apr-04	28-Apr-04	29-Apr-04	2	2	0	0				29-Apr-04													

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 99 Time Slice Windows Analysis Results for Window 28

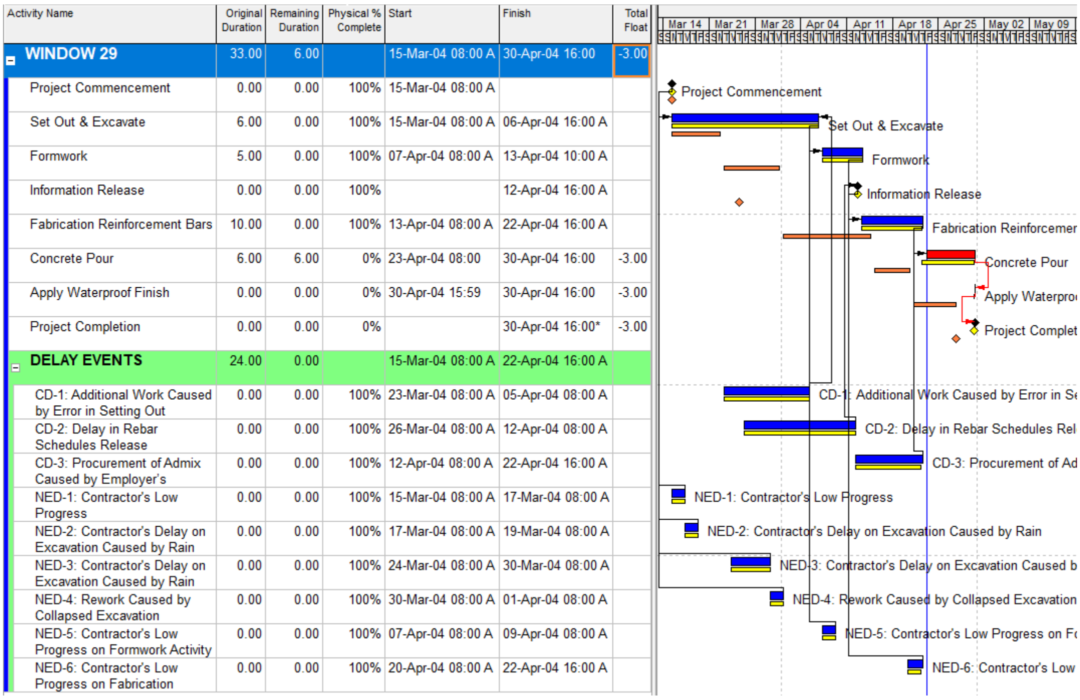
3.2.1.29 Window 29 – From 22 April 2004 08:00 to 23 April 2004 08:00

As also shown in Figure 12, the daily progress records for 22-Apr-04 were as follows:

- Fabrication Reinforcement Bars activity is completed. The cumulative percentage of completed Fabrication Reinforcement Bars activity is reported as 100%.
- Admix has been delivered to site.

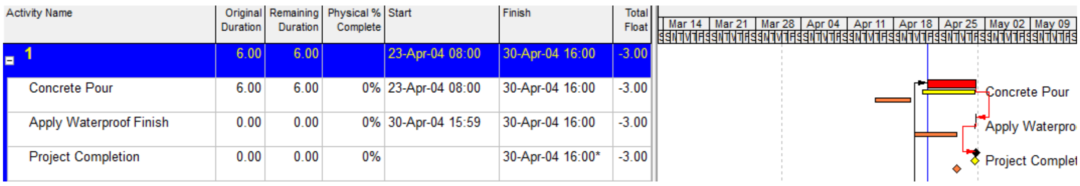
Figure 100 shows the updated program for Window 29. The project completion date is kept as 30-Apr-04, which means there is no critical delay compared to the previous window, and a 3-calendar-day delay compared to the as-planned program. Even though Admix is delivered to the site, the effect of delay event CD-3: Procurement of Admix Caused by Employer's Instruction continued. Concrete Pour activity could only be started on 23-Apr-04, as Admix was delivered on 22-Apr-04.

Figure 101 shows the float paths to the Project Completion milestone on the updated program. Float Path 1, the most critical path of the project, starts with Concrete Pour activity that had a delayed start date due to a delay in both the completion of Fabrication Reinforcement Bars and CD-3: Procurement of Admix Caused by Employer's Instruction activities.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 29	33.00	6.00		15-Mar-04 08:00 A	30-Apr-04 16:00	-3.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	0.00	100%	13-Apr-04 08:00 A	22-Apr-04 16:00 A	
Concrete Pour	6.00	6.00	0%	23-Apr-04 08:00	30-Apr-04 16:00	-3.00
Apply Waterproof Finish	0.00	0.00	0%	30-Apr-04 15:59	30-Apr-04 16:00	-3.00
Project Completion	0.00	0.00	0%		30-Apr-04 16:00*	-3.00
DELAY EVENTS	24.00	0.00		15-Mar-04 08:00 A	22-Apr-04 16:00 A	
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	100%	12-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	100%	20-Apr-04 08:00 A	22-Apr-04 16:00 A	

Figure 100 Updated Program for Window 29



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	6.00	6.00		23-Apr-04 08:00	30-Apr-04 16:00	-3.00
Concrete Pour	6.00	6.00	0%	23-Apr-04 08:00	30-Apr-04 16:00	-3.00
Apply Waterproof Finish	0.00	0.00	0%	30-Apr-04 15:59	30-Apr-04 16:00	-3.00
Project Completion	0.00	0.00	0%		30-Apr-04 16:00*	-3.00

Figure 101 Float Paths of Updated Program for Window 29

The results of Window 29 of the delay analysis are shown in a summary format in Figure 102. Impacts of paths from Set Out & Excavate to Project Completion and

Information Release to Project Completion are same as the previous window, which was a 3-calendar-day delay on project completion. However, from Employer Instruction to Project Completion path was delayed 1 day compared to the previous window and the cumulative compensable critical delay on the path has become 3 days.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 29																										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Fabrication Rebars	NED-6: Contractor Low Progress on Rebar Work	27-Apr-04	30-Apr-04	30-Apr-04	3	0	0	3					30-Apr-04												
Info. Release to Project Comp.	Fabrication Rebars	NED-6: Contractor Low Progress on Rebar Work	27-Apr-04	30-Apr-04	30-Apr-04	3	2	0	1					30-Apr-04												
Employer Inst. to Project Comp.	Concrete Pour	CD-3: Procurement of Admix	27-Apr-04	29-Apr-04	30-Apr-04	3	3	0	0					30-Apr-04												

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 102 Time Slice Windows Analysis Results for Window 29

3.2.1.30 Window 30 – From 23 April 2004 08:00 to 26 April 2004 08:00

23-Apr-04 was a working day, and 24-Apr-04 and 25-Apr-04 were non-working days. As also shown in Figure 12, the daily progress records for 23-Apr-04 were as follows:

- The cumulative percentage of completed Concrete Pour activity is reported as 15%.

Since the cumulative progress of Concrete Pour activity is 15% and the planned duration of the activity was 6 days, the earned duration of the activity is 0.9 days. Hence, the estimated remaining duration is updated in the program as 5.1 days. The planned daily progress of the activity was 16.7% and the achieved daily progress was 15%. Due to that, there is a Contractor delay caused by the low progress on the Concrete Pour activity in this window. An activity representing the delay event is created as NED-7: Contractor’s Low Progress on Concrete Pour Activity and linked with Concrete Pour activity, as the delay event affected this activity.

Figure 103 shows the updated program for Window 30. The project completion date is shifted to 04-May-04, which means that there is 4-calendar-day delay compared to the previous window and a 7-calendar-day delay compared to the as-planned program. The critical delay occurred due to a non-excusable delay event NED-7: Contractor’s Low Progress on Concrete Pour Activity. Even though the delay was working day, the effect of the delay on the Project Completion milestone was 4 calendar days due to the non-working days of 01-May, 02-May, and 03-May.

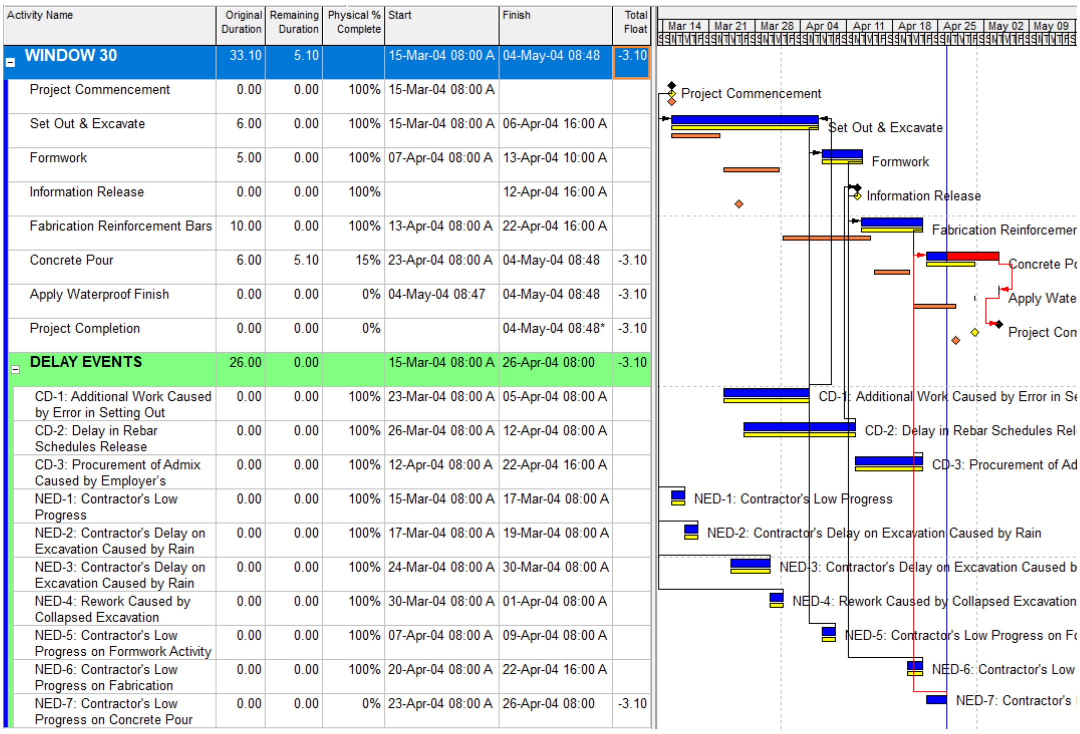
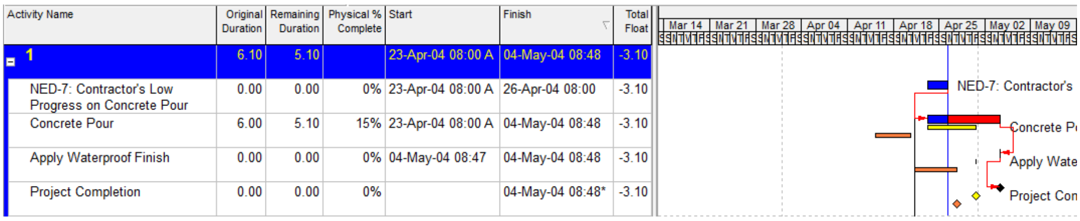


Figure 103 Updated Program for Window 30

Figure 104 shows the float paths to Project Completion milestone on the updated program. Float Path 1, which contains NED-7: Contractor’s Low Progress on Concrete Pour Activity, delays the project completion milestone date to 04-May-04, which means a 7-calendar-day delay compared to the as-planned program.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	6.10	5.10		23-Apr-04 08:00 A	04-May-04 08:48	-3.10
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	0%	23-Apr-04 08:00 A	26-Apr-04 08:00	-3.10
Concrete Pour	6.00	5.10	15%	23-Apr-04 08:00 A	04-May-04 08:48	-3.10
Apply Waterproof Finish	0.00	0.00	0%	04-May-04 08:47	04-May-04 08:48	-3.10
Project Completion	0.00	0.00	0%		04-May-04 08:48*	-3.10

Figure 104 Float Paths of Updated Program for Window 30

The results of Window 30 of the delay analysis are shown in a summary format in Figure 105. There is a 1-working-day and consequently a 4-calendar-day non-excusable delay on the Project Completion milestone in this window. Since Concrete Pour activity is included in all the paths of the project, the 4-calendar-day delay that occurred in this window is shown in all the paths.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 30

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays Tot.	CD	ED	NED	27-Apr-04 … 13-May-04
Set Out & Exc. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	30-Apr-04	04-May-04	7	0	0	7	04-May-04
Info. Release to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	30-Apr-04	04-May-04	7	2	0	5	29-Apr-04 04-May-04
Employer Inst. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	30-Apr-04	04-May-04	7	3	0	4	30-Apr-04 04-May-04

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

Figure 105 Time Slice Windows Analysis Results for Window 30

3.2.1.31 Window 31 – From 26 April 2004 08:00 to 27 April 2004 08:00

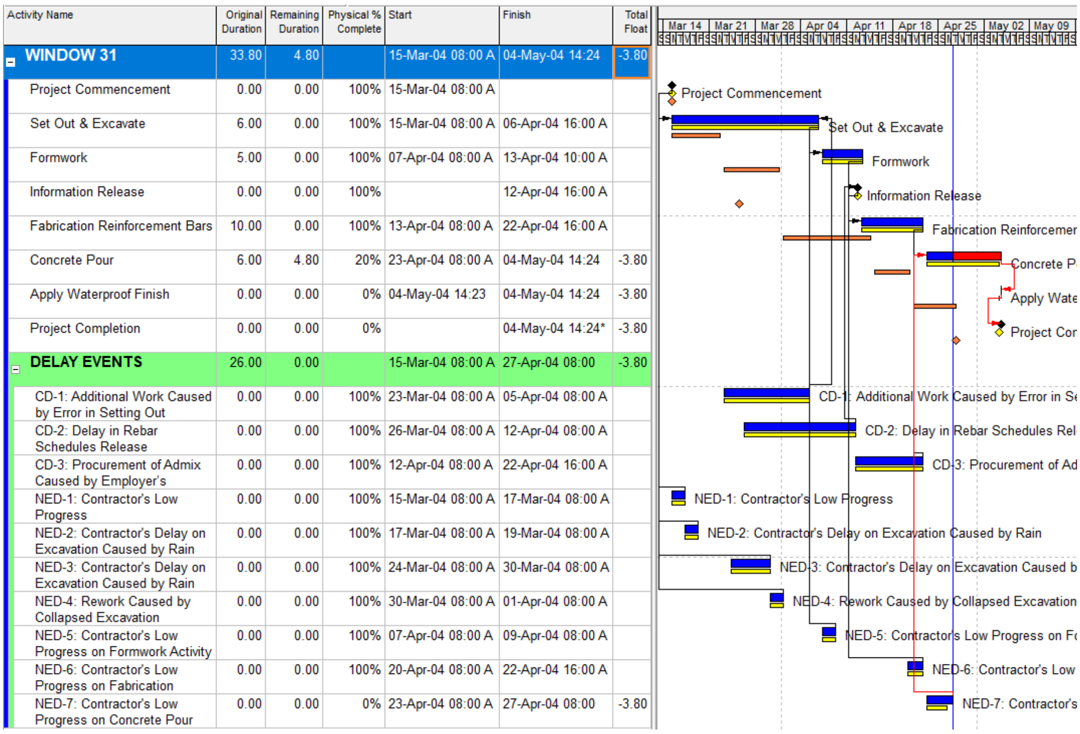
As also shown in Figure 12, the daily progress records for 26-Apr-04 were as follows:

- The cumulative percentage of completed Concrete Pour activity is reported as 20%.

Since the cumulative progress of Concrete Pour activity is 20% and planned duration of the activity was 6 days, the earned duration of the activity is 1.2 days. Hence, the estimated remaining duration is updated in the program as 4.8 days. The planned daily progress of the activity was 16.7% and the achieved daily progress was 5%. Due to that, the effect of non-excusable delay event NED-7: Contractor's Low Progress on Concrete Pour Activity is continued.

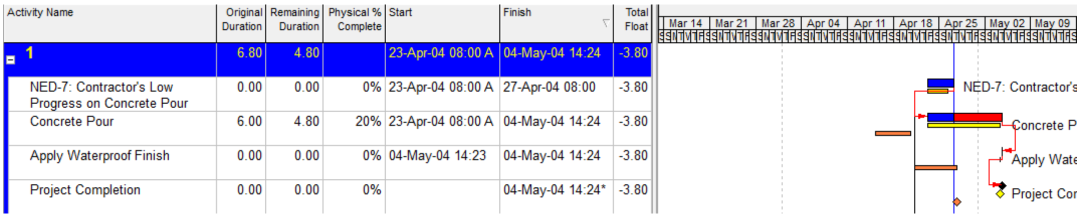
Figure 106 shows the updated program for Window 31. The project completion date is kept as 04-May-04, which means there is no delay compared to the previous window, and 7-calendar-day delay compared to the as-planned program. Even though the total float of the Project Completion milestone is reduced from -3.1 days to -3.8 days, it did not have an impact on the Project Completion date.

Figure 107 shows the float paths to the Project Completion milestone on the updated program. Float Path 1, which contains NED-7: Contractor's Low Progress on Concrete Pour Activity, delays the project completion milestone date to 04-May-04, which means a delay of 7 calendar days compared to the as-planned program.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 31	33.80	4.80		15-Mar-04 08:00 A	04-May-04 14:24	-3.80
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	0.00	100%	13-Apr-04 08:00 A	22-Apr-04 16:00 A	
Concrete Pour	6.00	4.80	20%	23-Apr-04 08:00 A	04-May-04 14:24	-3.80
Apply Waterproof Finish	0.00	0.00	0%	04-May-04 14:23	04-May-04 14:24	-3.80
Project Completion	0.00	0.00	0%		04-May-04 14:24*	-3.80
DELAY EVENTS	26.00	0.00		15-Mar-04 08:00 A	27-Apr-04 08:00	-3.80
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	100%	12-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	100%	20-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	0%	23-Apr-04 08:00 A	27-Apr-04 08:00	-3.80

Figure 106 Updated Program for Window 31



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	6.80	4.80		23-Apr-04 08:00 A	04-May-04 14:24	-3.80
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	0%	23-Apr-04 08:00 A	27-Apr-04 08:00	-3.80
Concrete Pour	6.00	4.80	20%	23-Apr-04 08:00 A	04-May-04 14:24	-3.80
Apply Waterproof Finish	0.00	0.00	0%	04-May-04 14:23	04-May-04 14:24	-3.80
Project Completion	0.00	0.00	0%		04-May-04 14:24*	-3.80

Figure 107 Float Paths of Updated Program for Window 31

The results of Window 31 of the analysis are shown in a summary format in Figure 108. The forecasted Project Completion date is the same as that of the previous window.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 31

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
						Tot.	CD	ED	NED																	
Set Out & Exc. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	04-May-04	04-May-04	7	0	0	7									04-May-04								
Info. Release to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	04-May-04	04-May-04	7	2	0	5				29-Apr-04					04-May-04								
Employer Inst. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	04-May-04	04-May-04	7	3	0	4					30-Apr-04				04-May-04								

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 108 Time Slice Windows Analysis Results for Window 31

3.2.1.32 Window 32 – From 27 April 2004 08:00 to 28 April 2004 08:00

As also shown in Figure 12, the daily progress records for 27-Apr-04 were as follows:

- The cumulative percentage of completed Concrete Pour activity is reported as 30%.

Since the cumulative progress of Concrete Pour activity is 30%, the estimated remaining duration is updated in the program as 4.2 days. The planned daily progress of the activity was 16.7% and the achieved daily progress was 10%. Hence, the effect of non-excusable delay event NED-7: Contractor’s Low Progress on Concrete Pour Activity is continued.

Figure 109 shows the updated program for Window 32. The project completion date is shifted to 05-May-04, which means there is a 1-calendar-day delay compared to the previous window and an 8-calendar-day delay compared to the as-planned program. The critical delay occurred due to non-excusable delay event NED-7: Contractor’s Low Progress on Concrete Pour Activity.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 32	34.20	4.20		15-Mar-04 08:00 A	05-May-04 09:36	-4.20
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	0.00	100%	13-Apr-04 08:00 A	22-Apr-04 16:00 A	
Concrete Pour	6.00	4.20	30%	23-Apr-04 08:00 A	05-May-04 09:36	-4.20
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 09:35	05-May-04 09:36	-4.20
Project Completion	0.00	0.00	0%		05-May-04 09:36*	-4.20
DELAY EVENTS	26.00	0.00		15-Mar-04 08:00 A	28-Apr-04 08:00	-4.20
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	100%	12-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	100%	20-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	0%	23-Apr-04 08:00 A	28-Apr-04 08:00	-4.20

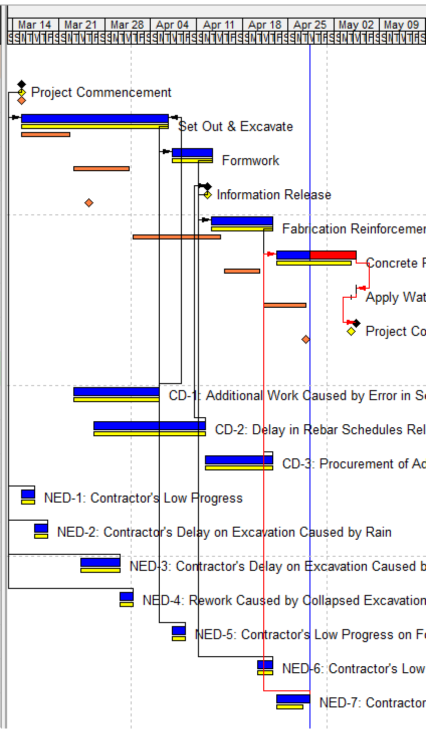
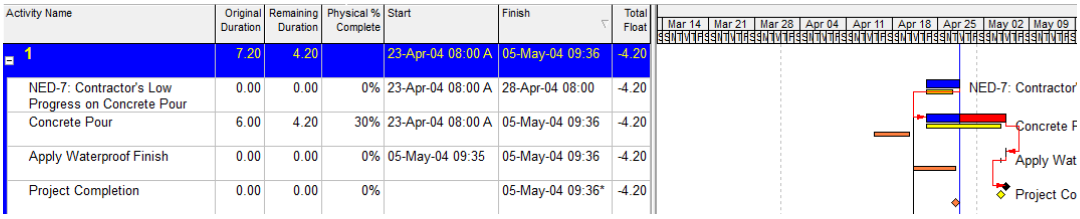


Figure 109 Updated Program for Window 32

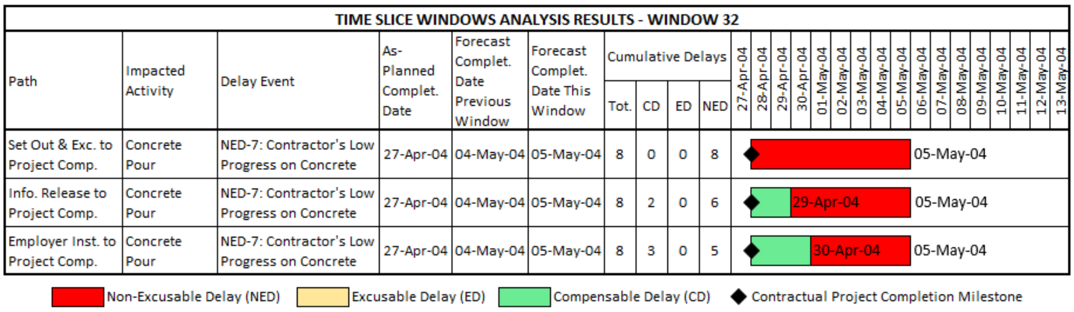
Figure 110 shows the float paths to Project Completion milestone on the updated program. Float Path 1, which contains NED-7: Contractor’s Low Progress on Concrete Pour Activity, delays the project completion milestone date to 05-May-04, which means a delay of 8 calendar days compared to the as-planned program.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	7.20	4.20		23-Apr-04 08:00 A	05-May-04 09:36	-4.20
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	0%	23-Apr-04 08:00 A	28-Apr-04 08:00	-4.20
Concrete Pour	6.00	4.20	30%	23-Apr-04 08:00 A	05-May-04 09:36	-4.20
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 09:35	05-May-04 09:36	-4.20
Project Completion	0.00	0.00	0%		05-May-04 09:36*	-4.20

Figure 110 Float Paths of Updated Program for Window 32

The results of Window 32 of the delay analysis are shown in a summary format in Figure 111. Because of the delay in Concrete Pour activity caused by low progress of the Contractor, a 1-calendar-day non-excusable delay occurred on Project Completion milestone in this window. Since Concrete Pour activity is included in all the paths of the project, the 1-calendar-day delay that occurred in this window is shown in all the paths.



TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 32

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays Tot.	CD	ED	NED	27-Apr-04 … 13-May-04
Set Out & Exc. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	04-May-04	05-May-04	8	0	0	8	05-May-04
Info. Release to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	04-May-04	05-May-04	8	2	0	6	29-Apr-04 05-May-04
Employer Inst. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	04-May-04	05-May-04	8	3	0	5	30-Apr-04 05-May-04

Figure 111 Time Slice Windows Analysis Results for Window 32

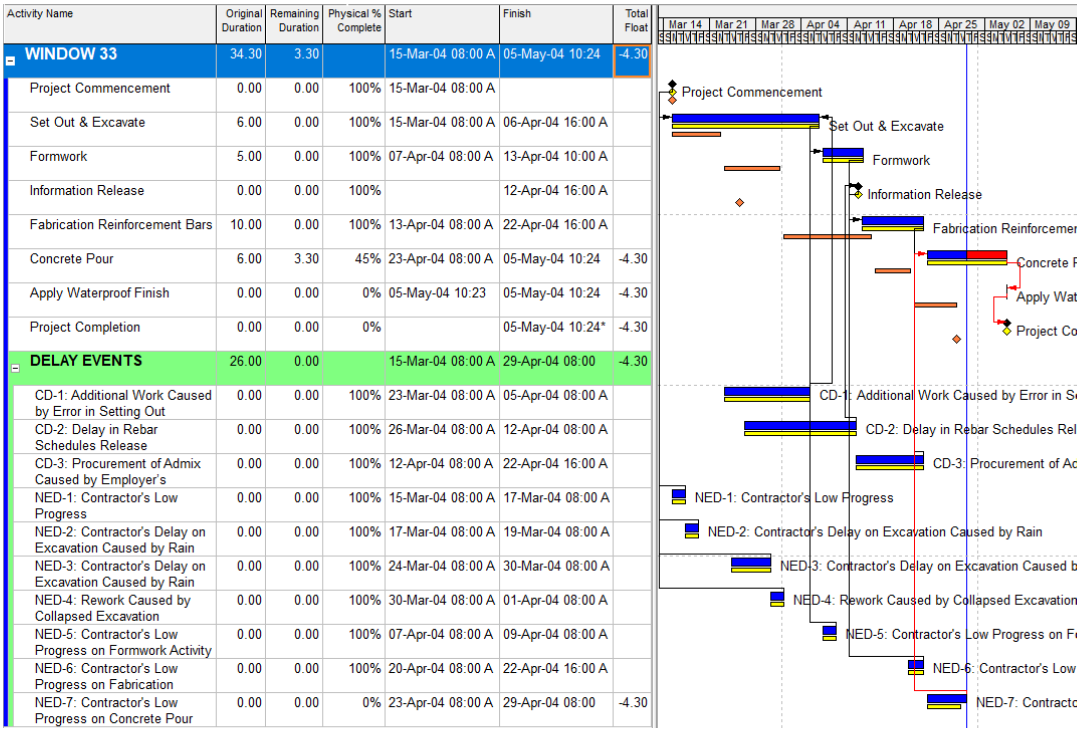
3.2.1.33 Window 33 – From 28 April 2004 08:00 to 29 April 2004 08:00

As also shown in Figure 12, the daily progress records for 28-Apr-04 were as follows:

- The cumulative percentage of completed Concrete Pour activity is reported as 45%.

Since the cumulative progress of Concrete Pour activity is 45% and the planned duration of the activity was 6 days, the earned duration of the activity is 2.7 days. Hence, the estimated remaining duration is updated in the program as 3.3 days. The planned daily progress of the activity was 16.7% and the achieved daily progress was 15%. Therefore, the effect of non-excusable delay event NED-7: Contractor’s Low Progress on Concrete Pour Activity is continued.

Figure 112 shows the updated program for Window 33. The project completion date is kept as 05-May-04, which means that there is no delay compared to the previous window and an 8-calendar-day delay compared to the as-planned program. Even though the total float of Project Completion milestone is reduced from -4.2 days to -4.3 days, it did not have impact on the Project Completion date.

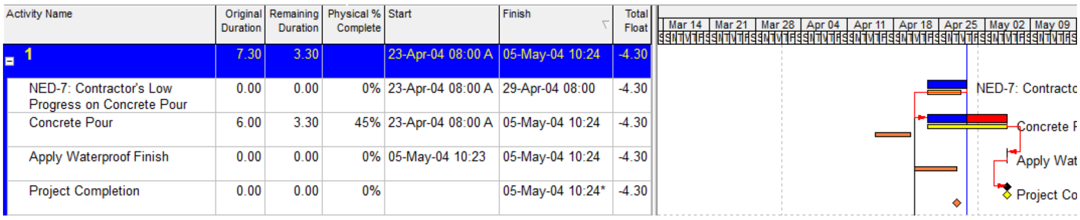


Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 33	34.30	3.30		15-Mar-04 08:00 A	05-May-04 10:24	-4.30
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	0.00	100%	13-Apr-04 08:00 A	22-Apr-04 16:00 A	
Concrete Pour	6.00	3.30	45%	23-Apr-04 08:00 A	05-May-04 10:24	-4.30
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 10:23	05-May-04 10:24	-4.30
Project Completion	0.00	0.00	0%		05-May-04 10:24*	-4.30
DELAY EVENTS	26.00	0.00		15-Mar-04 08:00 A	29-Apr-04 08:00	-4.30
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	100%	12-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	100%	20-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	0%	23-Apr-04 08:00 A	29-Apr-04 08:00	-4.30

Figure 112 Updated Program for Window 33

Figure 113 shows the float paths to the Project Completion milestone on the updated program. Float Path 1, which contains NED-7: Contractor’s Low Progress on

Concrete Pour Activity, delays the project completion milestone date to 05-May-04, which means an 8-calendar-day delay compared to the as-planned program.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	7.30	3.30		23-Apr-04 08:00 A	05-May-04 10:24	-4.30
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	0%	23-Apr-04 08:00 A	29-Apr-04 08:00	-4.30
Concrete Pour	6.00	3.30	45%	23-Apr-04 08:00 A	05-May-04 10:24	-4.30
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 10:23	05-May-04 10:24	-4.30
Project Completion	0.00	0.00	0%		05-May-04 10:24*	-4.30

Figure 113 Float Paths of Updated Program for Window 33

The results of Window 33 of the delay analysis are shown in a summary format in Figure 108. The forecasted Project Completion milestone date is the same as that of the previous window, which was 05-May-04.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 33

Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays Tot.	CD	ED	NED	27-Apr-04 … 13-May-04
Set Out & Exc. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	05-May-04	05-May-04	8	0	0	8	05-May-04
Info. Release to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	05-May-04	05-May-04	8	2	0	6	29-Apr-04 05-May-04
Employer Inst. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	05-May-04	05-May-04	8	3	0	5	30-Apr-04 05-May-04

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) Contractual Project Completion Milestone

Figure 114 Time Slice Windows Analysis Results for Window 33

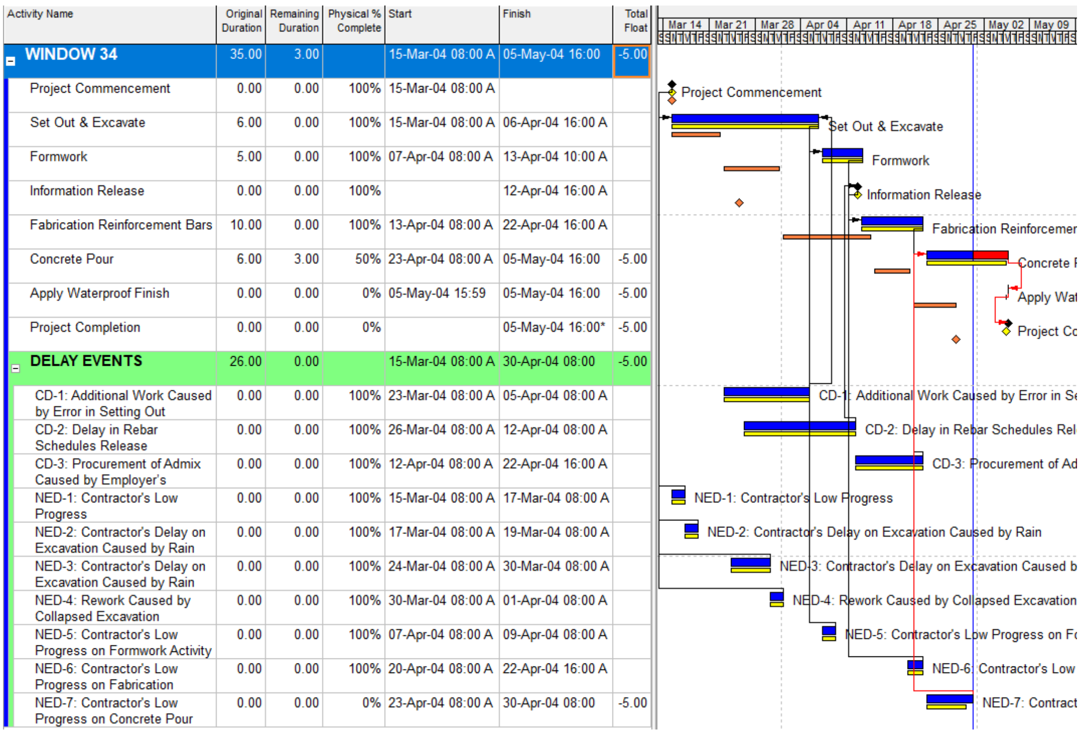
3.2.1.34 Window 34 – From 29 April 2004 08:00 to 30 April 2004 08:00

As also shown in Figure 12, the daily progress records for 29-Apr-04 were as follows:

- The cumulative percentage of completed Concrete Pour activity is reported as 50%.

Since the cumulative progress of Concrete Pour activity is 50%, the estimated remaining duration is updated in the program as 3 days. The planned daily progress of the activity was 16.7%, and the achieved daily progress was 5%. Due to that, the effect of non-excusable delay event NED-7: Contractor’s Low Progress on Concrete Pour Activity is continued.

Figure 115 shows the updated program for Window 34. The project completion date is kept as 05-May-04, which means that there is no delay compared to the previous window, and an 8-calendar-day delay compared to the as-planned program. Even though the total float of Project Completion milestone is reduced from -4.3 days to -5.0 days, it did not have impact on the Project Completion date.

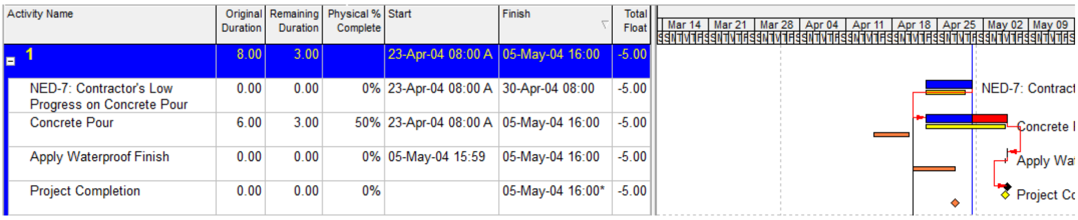


Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 34	35.00	3.00		15-Mar-04 08:00 A	05-May-04 16:00	-5.00
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	0.00	100%	13-Apr-04 08:00 A	22-Apr-04 16:00 A	
Concrete Pour	6.00	3.00	50%	23-Apr-04 08:00 A	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00
DELAY EVENTS	26.00	0.00		15-Mar-04 08:00 A	30-Apr-04 08:00	-5.00
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer’s	0.00	0.00	100%	12-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-1: Contractor’s Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor’s Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor’s Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor’s Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	
NED-6: Contractor’s Low Progress on Fabrication	0.00	0.00	100%	20-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-7: Contractor’s Low Progress on Concrete Pour	0.00	0.00	0%	23-Apr-04 08:00 A	30-Apr-04 08:00	-5.00

Figure 115 Updated Program for Window 34

Figure 116 shows the float paths to the Project Completion milestone on the updated program. Float Path 1, which contains NED-7: Contractor’s Low Progress on

Concrete Pour Activity, delays the project completion milestone date to 05-May-04, which means a delay of 8 calendar days compared to the as-planned program.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	8.00	3.00		23-Apr-04 08:00 A	05-May-04 16:00	-5.00
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	0%	23-Apr-04 08:00 A	30-Apr-04 08:00	-5.00
Concrete Pour	6.00	3.00	50%	23-Apr-04 08:00 A	05-May-04 16:00	-5.00
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 15:59	05-May-04 16:00	-5.00
Project Completion	0.00	0.00	0%		05-May-04 16:00*	-5.00

Figure 116 Float Paths of Updated Program for Window 34

The results of Window 34 of the analysis are shown in Figure 117. The forecasted Project Completion date is the same as previous window, which was 05-May-04.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 34										
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays Tot.	CD	ED	NED	27-Apr-04 … 13-May-04
Set Out & Exc. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	05-May-04	05-May-04	8	0	0	8	◆ NED; 05-May-04
Info. Release to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	05-May-04	05-May-04	8	2	0	6	◆ CD; NED 29-Apr-04; 05-May-04
Employer Inst. to Project Comp.	Concrete Pour	NED-7: Contractor's Low Progress on Concrete	27-Apr-04	05-May-04	05-May-04	8	3	0	5	◆ CD; NED 30-Apr-04; 05-May-04

Timeline columns: 27-Apr-04, 28-Apr-04, 29-Apr-04, 30-Apr-04, 01-May-04, 02-May-04, 03-May-04, 04-May-04, 05-May-04, 06-May-04, 07-May-04, 08-May-04, 09-May-04, 10-May-04, 11-May-04, 12-May-04, 13-May-04

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 117 Time Slice Windows Analysis Results for Window 34

3.2.1.35 Window 35 – From 30 April 2004 08:00 to 04 May 2004 08:00

30-Apr-04 was a working day, and 01-May-04, 02-May-04, and 03-May-04 were non-working days. As also shown in Figure 12, the daily progress records for 30-Apr-04 were as follows:

- The cumulative percentage of completed Concrete Pour activity is reported as 75%.

Since the cumulative progress of Concrete Pour activity is 75% and planned duration of the activity was 6 days, the earned duration of the activity is 4.5 days. Hence, the estimated remaining duration is updated in the program as 1.5 days. The planned daily progress of the activity was 16.7% and achieved daily progress was 25%. Due to that, the effect of non-excusable delay event NED-7: Contractor's Low Progress on Concrete Pour Activity has ended.

Figure 118 shows the updated program for Window 35. The project completion date is kept as 05-May-04, which means there is no delay compared to the previous window and an 8-calendar-day delay compared to the as-planned program. Even though higher progress is achieved than planned, it did not prepone the Project Completion forecast date. The acceleration achieved due to the higher progress than planned resulted in an increase in the total float of the Project Completion milestone from -5.0 days to -4.5 days.

Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 35	34.50	1.50		15-Mar-04 08:00 A	05-May-04 12:00	-4.50
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	0.00	100%	13-Apr-04 08:00 A	22-Apr-04 16:00 A	
Concrete Pour	6.00	1.50	75%	23-Apr-04 08:00 A	05-May-04 12:00	-4.50
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 11:59	05-May-04 12:00	-4.50
Project Completion	0.00	0.00	0%		05-May-04 12:00*	-4.50
DELAY EVENTS	26.00	0.00		15-Mar-04 08:00 A	30-Apr-04 08:00 A	
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	100%	12-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	100%	20-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	100%	23-Apr-04 08:00 A	30-Apr-04 08:00 A	

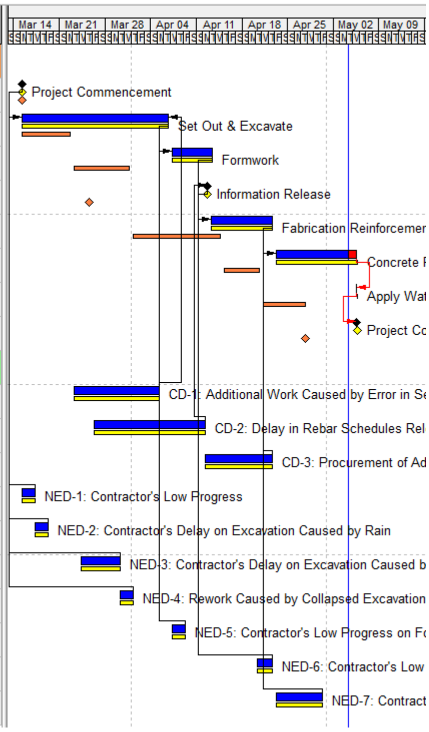
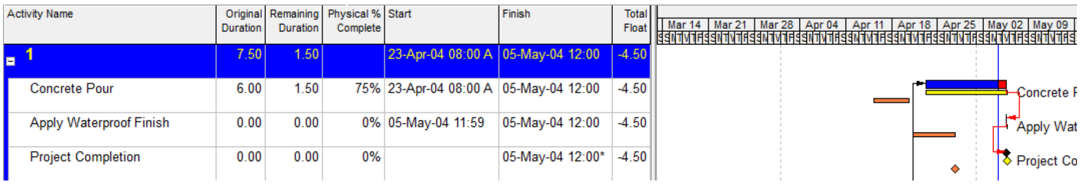


Figure 118 Updated Program for Window 35

Figure 119 shows the float paths to the Project Completion milestone on the updated program. Float Path 1, the most critical path of the project, starts with Concrete Pour activity that had a delayed start date due to a delay in the completion of both Fabrication Reinforcement Bars and CD-3: Procurement of Admix Caused by Employer's Instruction activities. Furthermore, Concrete Pour was delayed due to low progress and the actual duration of the activity is increased compared to planned duration.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
1	7.50	1.50		23-Apr-04 08:00 A	05-May-04 12:00	-4.50
Concrete Pour	6.00	1.50	75%	23-Apr-04 08:00 A	05-May-04 12:00	-4.50
Apply Waterproof Finish	0.00	0.00	0%	05-May-04 11:59	05-May-04 12:00	-4.50
Project Completion	0.00	0.00	0%		05-May-04 12:00*	-4.50

Figure 119 Float Paths of Updated Program for Window 35

The results of Window 35 of the delay analysis are shown in a summary format in Figure 120. The forecasted Project Completion milestone date is the same as that of the previous window, which was 05-May-04.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 35																											
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays: Tot.	CD	ED	NED	27-Apr-04	28-Apr-04	29-Apr-04	30-Apr-04	01-May-04	02-May-04	03-May-04	04-May-04	05-May-04	06-May-04	07-May-04	08-May-04	09-May-04	10-May-04	11-May-04	12-May-04	13-May-04
Set Out & Exc. to Project Comp.	Concrete Pour	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	0	0	8	◆									05-May-04							
Info. Release to Project Comp.	Concrete Pour	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	2	0	6	◆			29-Apr-04						05-May-04							
Employer Inst. to Project Comp.	Concrete Pour	No Delay This Window	27-Apr-04	05-May-04	05-May-04	8	3	0	5	◆				30-Apr-04					05-May-04							

Non-Excusable Delay (NED) | Excusable Delay (ED) | Compensable Delay (CD) | ◆ Contractual Project Completion Milestone

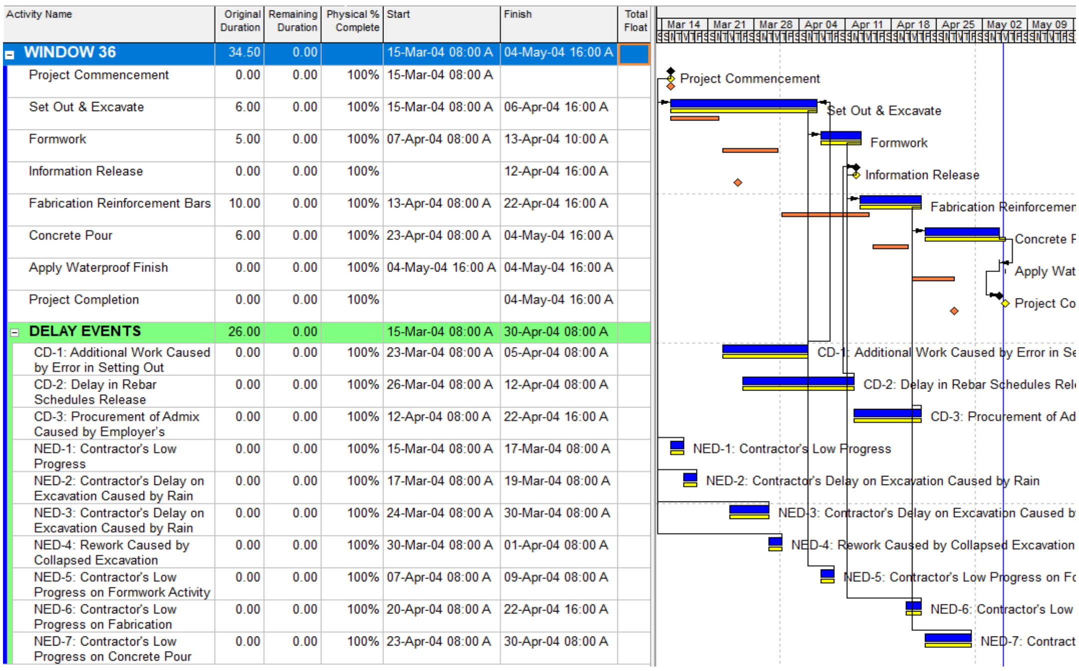
Figure 120 Time Slice Windows Analysis Results for Window 35

3.2.1.36 Window 36 – From 04 May 2004 08:00 to 05 May 2004 08:00

As shown in Figure 12, the daily progress records for 04-May-04 were as follows:

- The cumulative progress of Concrete Pour activity is reported as 100%.

Figure 121 shows the updated program for Window 36. Since Concrete Pour activity is completed, the Project Completion milestone is also completed on 04-May-04. The forecasted Project Completion milestone date was 05-May-04, which means there is a 1-day acceleration compared to the previous window and a 7-calendar-day delay compared to the as-planned program. As the project is completed in Window 36, the updated program for Window 36 can be also called the as-built program.



Activity Name	Original Duration	Remaining Duration	Physical % Complete	Start	Finish	Total Float
WINDOW 36	34.50	0.00		15-Mar-04 08:00 A	04-May-04 16:00 A	
Project Commencement	0.00	0.00	100%	15-Mar-04 08:00 A		
Set Out & Excavate	6.00	0.00	100%	15-Mar-04 08:00 A	06-Apr-04 16:00 A	
Formwork	5.00	0.00	100%	07-Apr-04 08:00 A	13-Apr-04 10:00 A	
Information Release	0.00	0.00	100%		12-Apr-04 16:00 A	
Fabrication Reinforcement Bars	10.00	0.00	100%	13-Apr-04 08:00 A	22-Apr-04 16:00 A	
Concrete Pour	6.00	0.00	100%	23-Apr-04 08:00 A	04-May-04 16:00 A	
Apply Waterproof Finish	0.00	0.00	100%	04-May-04 16:00 A	04-May-04 16:00 A	
Project Completion	0.00	0.00	100%		04-May-04 16:00 A	
DELAY EVENTS	26.00	0.00		15-Mar-04 08:00 A	30-Apr-04 08:00 A	
CD-1: Additional Work Caused by Error in Setting Out	0.00	0.00	100%	23-Mar-04 08:00 A	05-Apr-04 08:00 A	
CD-2: Delay in Rebar Schedules Release	0.00	0.00	100%	26-Mar-04 08:00 A	12-Apr-04 08:00 A	
CD-3: Procurement of Admix Caused by Employer's	0.00	0.00	100%	12-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-1: Contractor's Low Progress	0.00	0.00	100%	15-Mar-04 08:00 A	17-Mar-04 08:00 A	
NED-2: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	17-Mar-04 08:00 A	19-Mar-04 08:00 A	
NED-3: Contractor's Delay on Excavation Caused by Rain	0.00	0.00	100%	24-Mar-04 08:00 A	30-Mar-04 08:00 A	
NED-4: Rework Caused by Collapsed Excavation	0.00	0.00	100%	30-Mar-04 08:00 A	01-Apr-04 08:00 A	
NED-5: Contractor's Low Progress on Formwork Activity	0.00	0.00	100%	07-Apr-04 08:00 A	09-Apr-04 08:00 A	
NED-6: Contractor's Low Progress on Fabrication	0.00	0.00	100%	20-Apr-04 08:00 A	22-Apr-04 16:00 A	
NED-7: Contractor's Low Progress on Concrete Pour	0.00	0.00	100%	23-Apr-04 08:00 A	30-Apr-04 08:00 A	

Figure 121 Updated Program for Window 35

The results of Window 36 of the delay analysis are shown in a summary format in Figure 122. The Project is completed on 04-May-04, with a 1-day acceleration in Concrete Pour activity compared to the previous window. As a result, the project is delayed by 7 calendar days compared to the contractual project completion date.

TIME SLICE WINDOWS ANALYSIS RESULTS - WINDOW 36											
Path	Impacted Activity	Delay Event	As-Planned Complet. Date	Forecast Complet. Date Previous Window	Forecast Complet. Date This Window	Cumulative Delays				27-Apr-04, 28-Apr-04, 29-Apr-04, 30-Apr-04, 01-May-04, 02-May-04, 03-May-04, 04-May-04, 05-May-04, 06-May-04, 07-May-04, 08-May-04, 09-May-04, 10-May-04, 11-May-04, 12-May-04, 13-May-04	
						Tot.	CD	ED	NED		
Set Out & Exc. to Project Comp.	Concrete Pour	Acceleration This Window	27-Apr-04	05-May-04	04-May-04	7	0	0	7		04-May-04
Info. Release to Project Comp.	Concrete Pour	Acceleration This Window	27-Apr-04	05-May-04	04-May-04	7	2	0	5	29-Apr-04	04-May-04
Employer Inst. to Project Comp.	Concrete Pour	Acceleration This Window	27-Apr-04	05-May-04	04-May-04	7	3	0	4	30-Apr-04	04-May-04

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milestone

Figure 122 Time Slice Windows Analysis Results for Window 36

There is concurrent compensable and non-excusable delay up to 30-Apr-04, as shown in Figure 122. In the case of a concurrent delay, the Contractor bears the cost risk, and the Employer bears the time risk. Hence, concurrent delays can be considered as excusable delay since the Contractor is entitled to extension of time but is not entitled to be compensated for the additional prolongation costs that arise from the extension of time. Accordingly, based on the time slice windows analysis performed for this project, the Contractor is entitled to an extension time of 3 days, which would make the Project Completion milestone 30-Apr-04. However, the Contractor is not entitled to be compensated for the prolongation costs incurred for these 3 days of time extension as there is concurrent non-excusable delay as well. Furthermore, since there are only non-excusable delays between 30-Apr-04 and 04-May-04, the Contractor is exposed to liquidated damages for 4 days. The final results of the time slice windows analysis are given in Figure 123.

TIME SLICE WINDOWS ANALYSIS RESULTS - FINAL										
As-Planned Completion Date	Actual Completion Date	Cumulative Delays				Entitlement			27-Apr-04, 28-Apr-04, 29-Apr-04, 30-Apr-04, 01-May-04, 02-May-04, 03-May-04, 04-May-04, 05-May-04, 06-May-04, 07-May-04, 08-May-04, 09-May-04, 10-May-04, 11-May-04, 12-May-04, 13-May-04	
		Total	CD	ED	NED	Extension of Time	Cost Compensation	L/D Exposure		
27-Apr-04	04-May-04	7 days	0 days	3 days	4 days	3 days	0 days	4 days	30-Apr-04	04-May-04

Non-Excusable Delay (NED) Excusable Delay (ED) Compensable Delay (CD) ◆ Contractual Project Completion Milest

Figure 123 Final Time Slice Windows Analysis Results

CHAPTER 4

DISCUSSIONS

4.1 Comparison of Results of Delay Analysis Methods

Table 1 shows the comparison of the results of each delay analysis method performed in the SCL's Great Delay Analysis Debate (2006) and time slice windows analysis performed in this thesis on the case study project.

Table 1 Comparison of Results of Delay Analysis Methods

Delay Analysis Method	Entitlement to Extension of Time	Exposure to Liquidated Damages
Impacted As-Planned	7 days	-
As-Planned vs. As-Built	-	7 days
Collapsed As-Built	-	7 days
Time Impact	3 days	4 days
Time Slice Windows	3 days	4 days

The analysis performed using each delay analysis method in the Great Delay Analysis Debate was explained briefly and the reasons for the differences between time slice windows analyses are discussed in the following sections. In addition, the strengths and weaknesses of each method are revealed in the discussion.

4.1.1 Impacted As-Planned

In the Great Delay Analysis Debate (2006), the impacted as-planned method was used on the delay scenario by the analyst who prepared the Contractor's Claim. In this analysis, the selected delay causes, which were assumed to have occurred due to the Employer, are incorporated to the as-planned program in chronological order and the impact of each delay on Project Completion milestone is recorded by the analyst.

Firstly, the delay events of exceptional Inclement Weather & Remedials and Setting Out Remedials, which impacted the Set Out & Excavate activity, were added to the as-planned program to calculate the effect of these delay events, as shown in Figure 124. Due to these delay events, the Project Completion milestone was delayed to 11-May-04.

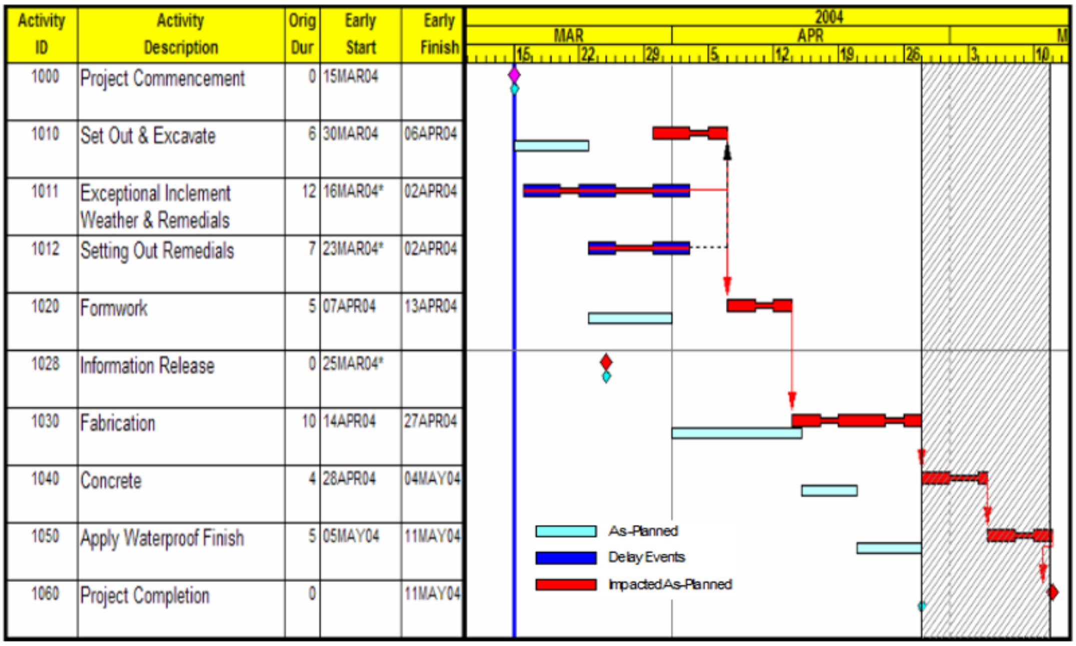


Figure 124 Impacted As-Planned – Effect of Exceptional Weather and Setting Out Remedials Delay Events

Secondly, the delay event related to late reinforcement details, which impacted the start of Fabricate Reinforcement Bars activity, was added to the impacted as-planned program to calculate the effect of the delay event, as shown in Figure 125. Due to the delay event, the Project Completion milestone was delayed to 12-May-04.

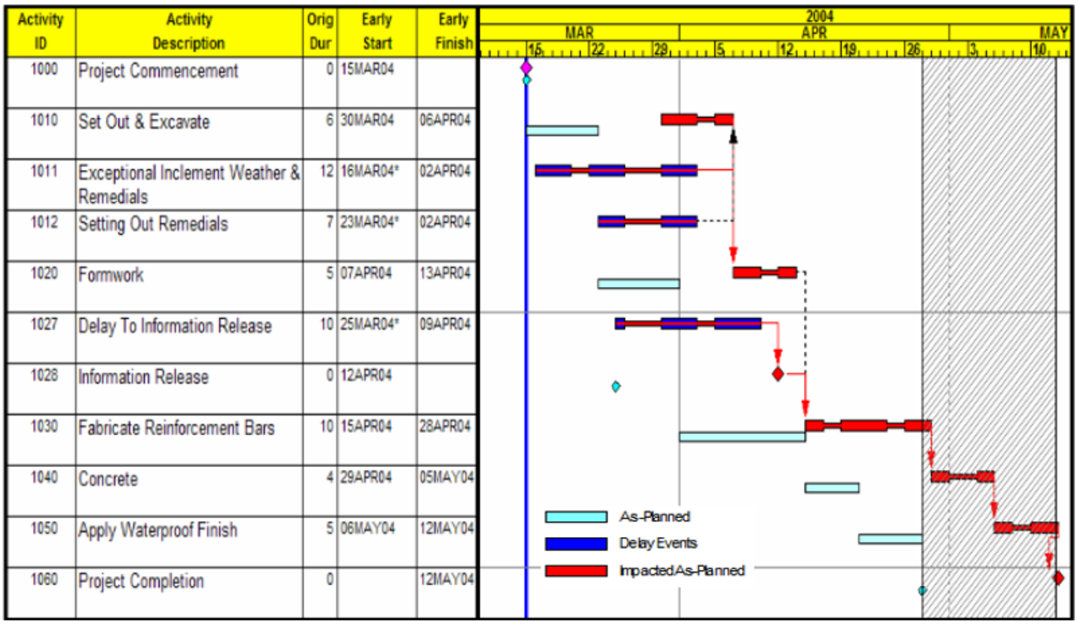


Figure 125 Impacted As-Planned – Effect of Delay to Information Release Delay Event

Finally, the delay event related to the delivery of Admix that was required based on the Employer’s Instruction to change the waterproofing system, which impacted the start of Concrete Pour activity, was added to the impacted as-planned program to calculate the effect of the delay event (Figure 126). There was no critical delay reported due to the Delivery of Admix delay event, and the impacted Project Completion milestone was kept as 12-May-04. In addition, the Contractor showed the acceleration caused by changing the waterproofing system as Apply Waterproof Finish activity was omitted, and Concrete Pour activity duration was actualized as 7 days instead of the as-planned duration of 4 days. Due to this acceleration, the impacted Project Completion milestone was calculated as 10-May-04.

In summary, the analyst concluded that the as-planned impacted analysis showed that due to the delays caused by the Employer, the project would have been completed on 12 May had the Contractor not accelerated and mitigated the effects of the Employer delays. Therefore, the Contractor has claimed a full extension of time to 04-May-04.

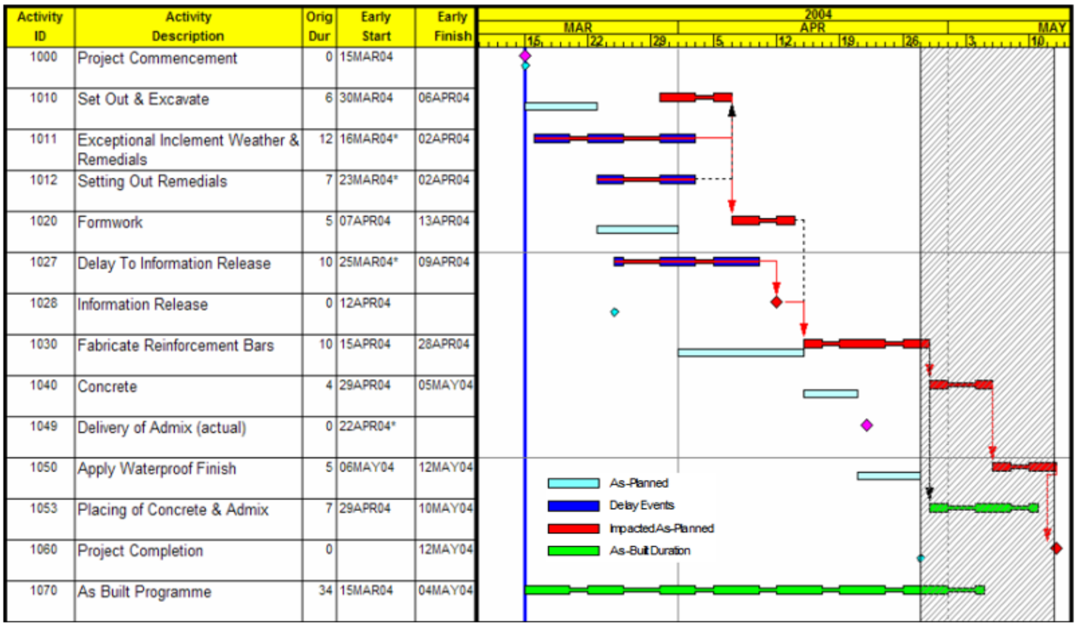


Figure 126 Impacted As-Planned – Effect of Delivery of Admix Delay Event

The impacted as-planned method assesses the potential impact of delays by incorporating them into the baseline schedule and projecting completion of contractual milestones based on planned activity durations and relationships. Thus, as-built program or contemporaneous program updates are not required to perform the impacted as-planned method, which makes the method easy to understand and implement.

The impacted as-planned method is a cause-and-effect type analysis method as it starts with the identification and description of delay causes and then seeks to establish their effects on a contractual milestone. Thus, most of the time, the analysis does not contain all the delay events that occur in the project. Table 2 shows the comparison of delay events identified during the performance of the time slice windows analysis method and the impacted as-planned method.

Table 2 Comparison of Delay Events in TSWA and IAP

Time Slice Windows Analysis	Impacted As-Planned
Non-Excusable - NED-1: Contractor's Low Progress	Not Included in the Analysis
Non-Excusable - NED-2: Contractor's Delay on Excavation Caused by Rain	Excusable - Exceptional Inclement Weather & Remedials
Non-Excusable - NED-3: Contractor's Delay on Excavation Caused by Rain	
Non-Excusable - NED-4: Rework Caused by Collapsed Excavation	
Compensable - CD-1: Additional Work Caused by Error in Setting Out	Compensable - Setting Out Remedials
Non-Excusable - NED-5: Contractor's Low Progress on Formwork Activity	Not Included in the Analysis
Compensable - CD-2: Delay in Rebar Schedules Release	Compensable - Delay to Information Release
Compensable - CD-3: Procure of Admix Caused by Employer Instruction	Compensable - Delivery of Admix
Non-Excusable - NED-6: Contractor's Low Progress on Fabrication Rebars	Not Included in the Analysis
Non-Excusable - NED-7: Contractor's Low Progress on Concrete Pour Activity	Not Included in the Analysis

The contractor only analyzed the delay events that were assumed to entitle claim to extension of time, as the types of delay events that were incorporated into the analysis were either excusable or compensable. The non-excusable delay events identified in time slice windows analysis are not incorporated into the analysis in the impacted as-planned method. Since the impacted as-planned method allows the claimant party to first identify the delay causes and then analyze the effect of the delays, the claimant party only includes delay events that were caused by the other party. Thus, the impacted as-planned method has a shortcoming when it comes to assessing concurrent delays. Usually, the claimant party accepts its delay only if the impacted project completion date is calculated to be earlier than the actual completion date. Additionally, as delay events are selected at the beginning of the analysis, it is not difficult to manipulate the methodology to render a favorable result to the claimant party.

The delay caused in the Set Out & Excavate activity due to rainy weather is categorized as a non-excusable delay. However, it was categorized as an excusable delay, as the analyst claimed that it was reported as exceptionally inclement weather in the impacted as-planned method. However, the Contract Document states that the Contractor is responsible for keeping the excavations free of water. It can be interpreted that the contractor needs to take all necessary measures to continue the work as per the plan, even in rainy weather. In addition, no indication of exceptionally inclement weather was made in the Contractor's daily progress records. It is also reported that the pumps failed, and because of that the excavations collapsed which caused the dominant delay in Set Out & Excavate activity. According to the Contract Document, supplying labor, plants, and materials falls under the responsibility of the Contractor. Hence, maintaining the plants, which would include the pumps, is also within the Contractor's scope of work. Therefore, the delay caused by rainy weather is categorized as a non-excusable delay in the Time Slice Windows Analysis. In summary, the claimant party usually tries to attribute the responsibility of the delays to the other party whenever possible regardless of the delay analysis method. Even though the type of delay events impacting the Set Out & Excavate activity differ, in both analyses the effect of the delay on Set Out & Excavate activity on the Project Completion milestone was calculated as 11-May-04 because there were no changes in the schedule logic and there was no compensable delay which was driving the Project Completion milestone, as reported in Window 15. Even though the delayed project completion date was same in both analyses, when Set Out & Excavate activity was completed, entitlement to extension of time was different for two reasons. The first reason is due to the differing definitions for the delay type for the Set Out & Excavate activity delay caused by rainy weather. The second reason is that the concurrent effect on the Project Completion milestone caused by compensable delay event CD-2: Delay in Rebar Schedules Release, which is explained in Window 15 of time slice windows analysis, had not yet been included in the impacted as-planned analysis. This difference also provides evidence that the impacted as-planned method has a weakness with regard to identifying concurrent delays.

The second delay event analyzed by the impacted as-planned method was a compensable delay event, namely a delay on information release. The delay event was categorized as a compensable delay during the performance of a time slice windows analysis as well. The delay event concerning information release pushed the project completion milestone to 12-May-04. However, the same delay event pushed the project completion date to 05-May-04 in time slice windows analysis, as explained in Window 19. As explained in detail below, the reason for the result difference between the two analyses methods is the incapability of the impacted as-planned method to consider schedule logic changes, accelerations, concurrency, and the real-time impact of a delay event.

- In the as-planned program, there was a 2-day lag in the relationship between Information Release and Fabrication Reinforcement Bars activities to represent lead time of rebar procurement. However, during the execution of the project, the procurement of rebars was anticipated by the Contractor and the schedule logic was changed by revising the lag time from 2 days to 0 days.

- The Employer instructed the Contractor to use the Admix in the concrete instead of waterproof finish, which resulted in an acceleration on 12-Apr-04, which was analyzed in Window 19. However, this acceleration had not yet been considered in the analysis with the IAP method because delay events are inserted into the as-planned program one by one without considering the actual status of the program when the delay event occurred. Contemporaneous schedule updates are not used in the IAP method, which is a weakness of the method since the real effect of a delay event can only be analyzed according to the status of the project at the time when the delay event occurred.
- In addition to the delay caused by compensable delay that affected the Information Release activity, there was also concurrent excusable and non-excusable delay, as reported in Window 19 of the time slice window analysis on the path from Set Out & Excavate to Project Completion. However, since only selected compensable delay events are analyzed in the impacted as-planned method, no concurrent delay was identified in the method. As highlighted before, the impacted as-planned method cannot truly identify concurrent delay.

The last delay event analyzed in the IAP method was related to the delay in the delivery of Admix caused by Employer's instruction of changing the waterproofing system. In the IAP method, the delivery of Admix did not affect the critical path, as Admix was delivered on 22-Apr-04 and Concrete Pour activity start was pushed to 29-Apr-04 after the impact of the delay event related to the information release of rebars. However, Concrete Pour activity actually started on 23-Apr-04 according to the progress records. This is also evidence to the fact that the IAP method produces only theoretical results and does not give correct conclusions on what has happened and what caused the delay to the project. Furthermore, the Project Completion milestone was delayed to 12-May-04 at the end of the analysis performed by the impacted as-planned method despite the project having been completed on 04-May-04. This variance is because the method does not take into account all the delay events, mitigations, accelerations, schedule logic changes, contemporaneous records and updated programs, the real-time effects of delay events considering the status of the project when they occurred.

Based on the discussion and comparison of results of IAP method on the delay scenario with TSWA performed in this thesis, strengths and weaknesses of IAP method are summarized in Table 3.

Table 3 Strengths and Weaknesses of Impacted As-Planned Method

Strenghts	Weaknesses
• Easy to understand • Does not require as-built program • Does not require contemporaneously updated programs • Does not require analysis of all delay events	• Produces theoretical results • Relies on as-planned logic and durations • Changes in program logic are ignored • Concentrates only on delays of other party • Cannot identify concurrent delays • Real-time impact of delay events when they occurred cannot be analyzed • Easy to manipulate the results • Difficulty to incorporate accelerations and mitigations • Cannot identify delays caused by loss of productivity

4.1.2 As-Planned vs. As-Built Method

In the Great Delay Analysis Debate (2006), as planned vs. as-built method was used on the delay scenario by the analyst who prepared the Employer's defense for the Contractor's Claim. In this analysis, as planned and as-built programs are compared and causes of delays in each activity is identified. Afterwards, impact of delays on project completion milestone are evaluated.

Figure 127 shows the as-planned vs. as-built analysis done by the analyst of the Employer. The analyst has interpreted the comparison of as-planned and as-built program as below.

- The delay occurred in Set Out & Excavate activity has caused by setting out error and collapse of excavation due to pump failure. The analyst determined that these delay events were attributable to the Contractor.
- It is acknowledged that Information Release activity was delayed due to Employer's late supply of information. However, since Information Release activity finished on the same date as the Formwork activity, the delay caused by this event did not drive the start of Fabricate Reinforcement Bars activity. Hence, the Contractor is not entitled to extension of time.
- It is acknowledged that the instruction to use Admix instead of waterproof finish can be considered as a variation order, which is the Employer's risk according to Contract Document. However, Admix was actually delivered on the day the Contractor finished the rebar work. Hence, the delivery of Admix did not cause any impact on the start of Concrete Pour, so the Contractor is not entitled to extension of time.
- The Employer concluded by performing as-planned vs. as-built delay analysis method that it did not cause any delay to project completion and due to that the Contractor is responsible for the entire period of delay. Hence, the Employer is entitled to deduct Liquidated Damages from the Contractor for entire period of delay which is 7 calendar days.

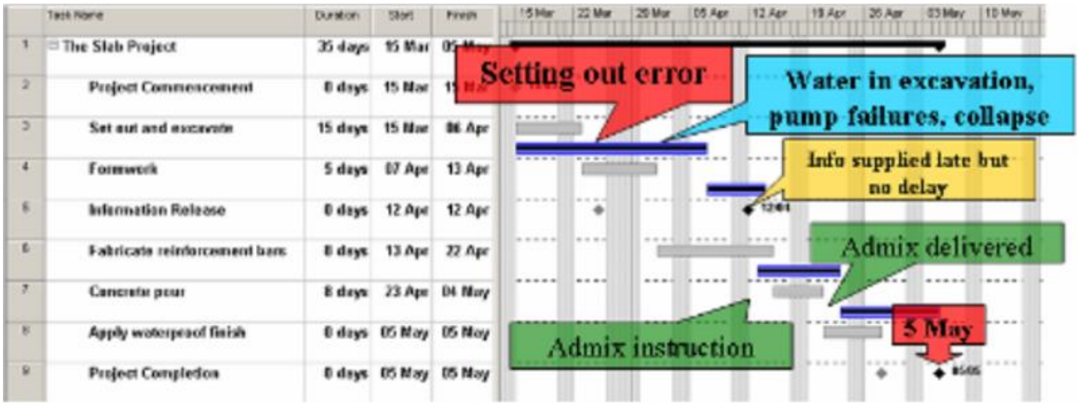


Figure 127 As-Planned vs. As-Built Method – Employer's Defense

Four separate delay causes have been identified during time slice windows analysis for Set Out & Excavate activity. Three out of four delay events were categorized as non-excusable delays and one of the delay events was categorized as compensable delay, which was CD-1: Additional Work Caused by Error in Setting Out. The result of the analysis in Window 15, when Set Out & Excavate activity was completed, shows that there was 14 days delay in project completion milestone and 10 days the overall delay was excusable delay and 4 days of the overall delay was non-excusable delay. 10 days excusable delay were reported due to concurrent effects of compensable and non-excusable delays. It is evident that time slice window analysis can assess impact of concurrent delays that affected the same activity. However, the as-planned vs. as-built method simply determines the cumulative effect of all delay events together rather than analyzing each delay event separately. Even if the setting out error was identified as compensable delay when performing as-planned vs. as-built method, it would not be possible to calculate the effect of compensable delay which would be concurrent to the non-excusable delay of excavation collapse due to pump failure because the method simply compares the as-planned vs. as-built schedule using common sense and there is no advanced technique being applied.

As-planned vs. as-built method can detect concurrent delays to some extent as it identifies both employer and contractor delays while comparing the programs. In the Employer's analysis, both delay in information release and admix delivery were identified as Employer's responsibility. However, it was concluded that since these delay events did not affect the project completion date more than other delay events, the Contractor is not entitled to extension of time. The compensable delay events related to Information Release and Admix were actually concurrent delays with other non-excusable delays. SCL (2017) suggests in the Delay and Disruption Protocol that where Contractor Delay to Completion occurs or has an effect concurrently with Employer Delay to Completion, the Contractor's concurrent delay should not reduce any EOT due. Based on this suggestion, results of window 19 and window 29, which are the windows when information release and procurement of admix were completed respectively, had shown the concurrent delays. Later, these concurrent delays were taken into consideration while establishing the entitlement as reported in final results of time slice windows analysis.

As highlighted in Window 19 of the time slice windows analysis, schedule logic was changed from the as-planned schedule. However, it was not visible in the analysis performed using the as-planned vs. as-built method because it does not take into consideration the relationship between activities and only compares dates and durations of as-planned and as-built schedule activities to evaluate the delays. The method does not even require a program developed using critical path method, and only bar chart of as-planned and as-built schedules is considered as enough to perform the analysis. However, in case of major changes in schedule logic between as-planned and as-built schedules, it would almost be impossible to compare the effect of delays.

In the time slice windows analysis, the effect on critical path is measured within specific timeframes called windows. Due to that, the analyst must assign a delay cause that occurred in that specific timeframe to the delayed activity, which makes manipulation of delay causes almost impossible. On the other hand, it is easier to make manipulation on the causes of delays on each activity if there are competing delay events that affected the same activity or phase in as-planned vs. as-built method.

As-planned vs. as-built method cannot measure the impact of a delay event on contractual milestones at the time it has occurred because it cannot track the total float by using critical path method. Hence, the method cannot analyze the real-time impact of delays and accelerations. Thus, it is highly possible to not to realize a delay event that has not impacted a contractual milestone by its overall duration and has consumed some of the total float available on the activity at the time delay event occurred.

As explained in Window 18 of time slice windows analysis, critical path has changed from Set Out & Excavate to Project Completion path to Information Release to Project Completion path. Later in window 19, due to acceleration in rebar procurement, critical path has changed again to the path from Set Out & Excavate to Project Completion. However, critical path changes that has occurred in the project were not detected using as-planned vs. as-built method which is one of the reasons that it cannot analyze the real-time impact of delays and accelerations.

In summary, the method considers both planned and as-built programs to assess the effects of delays, distinguishing and measuring delays caused by both the employer and contractor relaying on records and common sense. Nevertheless, a significant limitation of this method is that it only examines the overall impact of all delays collectively, rather than evaluating each delay event separately. This method is better to be used as a starting point, before implementing a complex method, in order to understand the principal characteristics of the matter. Based on the discussion and comparison of results of as-planned vs. as-built method on the delay scenario with time slice windows analysis performed in this thesis, strengths and weaknesses of the method are summarized in Table 4.

Table 4 Strengths and Weaknesses of As-Planned vs. As-Built Method

Strenghts	Weaknesses
• Easy to understand • Does not require contemporaneously updated programs • Does not require program created with critical path method • Considers both contractor and employer delays • Concurrency can be detected • Accelerations and mitigations can be detected • Conclusions are readily supported by as-built records and common sense • Does not result in theoretical contractual milestone completion date because it is effect-and-cause type analysis method.	• Difficult to calculate the effect of delays on contractual milestones as it does not follow a structured methodology or advanced technique • Evaluates the net impact of delays as a whole rather than analyzing impact of individual delay events • Difficult to calculate effect of concurrent delays • Difficult to calculate acceleration and mitigation effects on contractual milestone • Difficult to analyze if as-built logic logic altered from as-planned logic during execution • Real-time impact of delay events when they occurred cannot be analyzed • Relatively easy to manipulate the results • Change of critical path cannot be identified • As-built program is required. It needs to be created by the analyst from as-built records, if as-built Program is not already available. • Not suitable for complex and large scale projects

4.1.3 Collapsed As-Built Method

In the Great Delay Analysis Debate (2006), collapsed as-built method was used on the delay scenario by the analyst who prepared the Engineer's decision for the Contractor's Claim. In this analysis, as-built program is created using daily progress records. Afterwards, events caused by Employer were subtracted from the as-built program to calculate what would be the project completion date if those events had not occurred. Hence, the Contractor is considered to be entitled to extension of time according to the difference between actual project completion date and the project completion date calculated at the end of the analysis conducted with collapsed as-built method.

Figure 128 shows the as-built program created by the analyst based on daily progress records. Only the as-built critical path was created by the analyst to perform the analysis on the critical path and other paths were not included in the as-built program. Collapsed as-built analysis was performed as explained below.

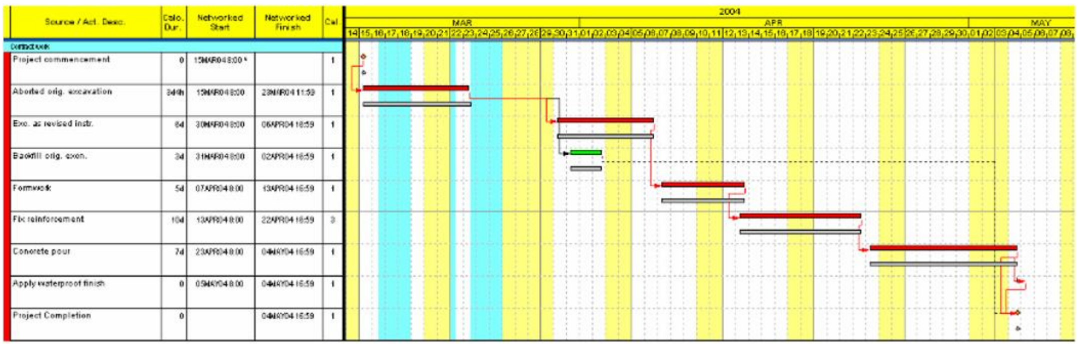


Figure 128: Collapsed As-Built Method – As-Built Program

- As collapsed as-built delay analysis is a cause-and-effect type of analysis, the analyst needs to identify which delay or acceleration events are to be considered in the analysis. Analyst has determined to analyze the effects of delay events that are considered to delay the critical path, and other delay events were categorized as chaff and not included in the analysis.

- Firstly, delay caused by Employer's instruction to incorporate Admix in concrete to slab was subtracted from the as-built program to measure the impact of it. The analyst determined that concrete pour duration was increased by 1 day due to this instruction. Hence, concrete pour duration was decreased from 7 day to 6 day in the analysis. Hence, project completion date was advanced by 1 calendar day as shown in Figure 129.

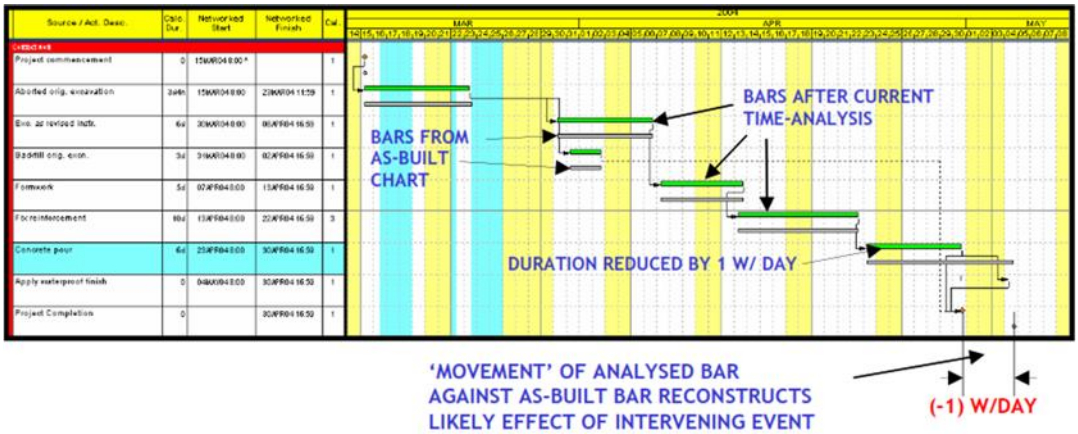


Figure 129 Collapsed As-Built Method – 1st Collapse

- Secondly, the delay caused by employer's instruction to excavate in new location due to error in setting out was subtracted from the as-built program to measure the effect of it on the project completion milestone. Duration of Aborted Orig. Excavation activity, which was included in the as-built program created by the analyst, was set to 0 days to calculate what would be the project completion date but for this delay event caused by the Employer. Figure 130 shows that project completion date has become 27-Apr-04, which is 7 calendar days earlier than actual completion.

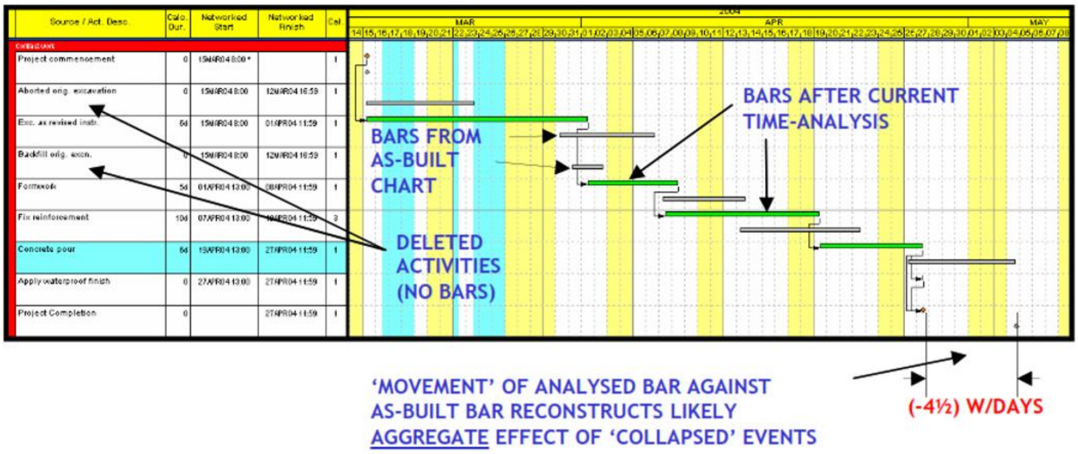


Figure 130 Collapsed As-Built Method – 2nd Collapse

- The last event analyzed was related to Employer's instruction to omit applied waterproof finish to slab. This event has caused acceleration in the program. To calculate the effect of this acceleration, duration of Apply Waterproof Finish activity was set to its as-planned duration of 5 working days. As shown in Figure 131, the project completion date shifted to 05-May-04, which is 1 calendar day later than actual project completion date.

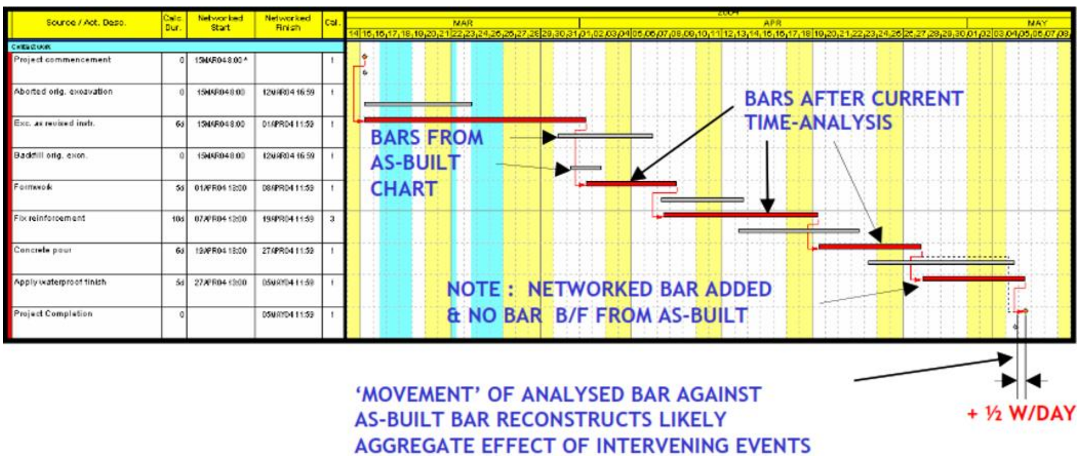


Figure 131 Collapsed As-Built Method – 3rd Collapse

- In conclusion, the effects of events that actually impacted the as-built critical path show that if those events were not occurred, the Contractor would have completed the project 1 calendar day later than it actually did. Accordingly, the Contractor is not entitled to receive extension of time and is liable to pay the liquidated damages.

The collapsed as-built method is a cause-and-effect type of analysis method, as it starts with the identification and description of delay causes and thereafter seeks to establish their effects on a contractual milestone by subtracting them from the as-built program or critical path. Thus, most of the time, the analysis does not contain all the delay events that occurred in the project. Table 5 shows the comparison of delay events identified during performance of analyses of the time slice windows analysis method and the impacted as-planned method.

As shown in Table 5, only some of the compensable delay events are used in the analysis performed with the CAB method. Since none of the non-excusable delay events are analyzed, it was not possible to calculate whether there was any concurrent delay in the project. Usually, when a party conducts a CAB analysis, the analyst considers only the delays caused by the other party to prove the effects of the other party's delays on the project completion. Therefore, concurrent delays cannot be recognized using this delay analysis and this is a weakness of the CAB method.

Table 5 Comparison of Delay Events in TSWA and CAB

Time Slice Windows Analysis	Collapsed As-Built
Non-Excusable - NED-1: Contractor's Low Progress	Not Included in the Analysis
Non-Excusable - NED-2: Contractor's Delay on Excavation Caused by Rain	Not Included in the Analysis
Non-Excusable - NED-3: Contractor's Delay on Excavation Caused by Rain	Not Included in the Analysis
Non-Excusable - NED-4: Rework Caused by Collapsed Excavation	Not Included in the Analysis
Compensable - CD-1: Additional Work Caused by Error in Setting Out	Compensable - Employer's Instruction to Excavate in New Location
Non-Excusable - NED-5: Contractor's Low Progress on Formwork Activity	Not Included in the Analysis
Compensable - CD-2: Delay in Rebar Schedules Release	Not Included in the Analysis
Compensable - CD-3: Procure of Admix Caused by Employer Instruction	Compensable - Employer's Instruction to Incorporate Admix in Concrete to Slab
Non-Excusable - NED-6: Contractor's Low Progress on Fabrication Rebars	Not Included in the Analysis
Non-Excusable - NED-7: Contractor's Low Progress on Concrete Pour Activity	Not Included in the Analysis

As shown in Figure 130, during the second collapse, when the delay occurred due to the setting out error being subtracted from the as-built critical path, the project completion date was brought to a date that was 7 calendar days earlier. However, as shown in Table 5, it was not only the setting out error that delayed the Set Out & Excavate activity, but the rework caused by the collapsed excavation had also affected it. Effects of delays on Set Out & Excavate activity had completed in Window 13 of the TSWA, and the dominant delay was due to the rework caused by the collapsed excavation. Thus, when the effects of the setting out error were subtracted from the as-built critical path, there should not have been any changes to the project completion date because of the effects of other concurrent delay events on Set Out & Excavate activity. However, the as-built critical path that was created to be used in the analysis did not include the activity related to the collapse of the excavation, which caused an error in the analysis. As also evident by this example, one of the drawbacks of the collapsed as-built method is that the analyst must create an as-built program from the records, which is laborious and highly subjective, and subject to errors or even manipulation.

Only the as-built critical path was created in the collapse as-built method which is from Set Out & Excavate to Project Completion. However, as explained during performance of TSWA in this thesis, there were also other paths which delayed the project completion date, such as paths from Information Release to Project Completion and from Employer's Instruction to Project Completion. The CAB method would not give reliable results unless all the paths that are affected by delay events are included in the analysis. For instance, the project completion date was brought to a date that was 7 days earlier after the subtraction of the delay event related to the Employer's instruction to excavate in a new location, as illustrated in the 2nd collapse. Furthermore, the start date of the activities related to reinforcement work and concrete pour had become 07-Apr-04 and 19-Apr-04, respectively. Since the information release of rebar schedules had only been done by the Employer on 12-Apr-04, it would not have been possible to start reinforcement work before 13-Apr-04. In addition to that, since Admix had only been delivered on 22-Apr-04, it would not be possible to start concrete pour before 23-Apr-04. Due to the fact that the paths that include Information Release and Admix delivery activities were not included in the as-built program used in the CAB analysis, the result of the analysis was misleading. Generally, the analysis focuses on the as-built critical path in the CAB method for this reason it does not yield accurate results, as the delays that occurred on the near-critical paths are not taken into consideration.

The CAB method cannot measure the impact of a delay event on contractual milestones at the time it has occurred because it cannot track the total float. Hence, the method cannot analyze the real-time impact of delays and accelerations. For this reason, it is highly possible to not to realize a delay event has not impacted a contractual milestone by its overall duration and has consumed some of the total float available on the activity at the time delay event occurred.

As explained in Window 18 of the time slice windows analysis, the critical path changed from Set Out & Excavate to Project Completion path to Information Release to Project Completion path. Later in Window 19, due to acceleration in rebar procurement, the critical path changed again to the path from Set Out & Excavate to Project Completion. However, critical path changes that occurred were not detected in the CAB method. In fact, only the as-built critical path was analyzed as if there had been a single unchanging critical path throughout the life of a project, which is unlikely to happen in any construction project.

Concurrent delays can be detected using the CAB method only if all the activities, whether they are on the critical path or not, are included in the as-built program that is to be used in the analysis. However, even building an as-built critical path from records and interpreting the as-built logic between activities is laborious and requires a lot of assumptions, let alone the creation of a complete as-built program. Additionally, not only the selection of other the party's delay events but all the delay events occurred due to both parties should be analyzed to detect concurrent delays accurately because the analyst would not know which delay events really affected the project completion before the performance of the analysis. Identifying all the delay events from the as-built records without available contemporaneous updated programs that would show the effect of delays in each period would almost be impossible.

Based on the discussion and comparison of results of the collapsed as-built method on the delay scenario with time slice windows analysis performed in this thesis, the strengths and weaknesses of the method are summarized in Table 6.

Table 6 Strengths and Weaknesses of Collapsed As-Built Method

Strenghts	Weaknesses
• Performed using as-built program, fact based analysis • Does not require as-planned program • Does not require contemporaneously updated programs • Easy to understand • Has a methodology to calculate the effects of delay events	• Produces theoritical results • Requires subjective assumptions while creating as-built program with logic • Easy to manipulate the results • Concentrate on delays of other party • Only selected delay events are analyzed • Cannot identify concurrent delays • Changes of critical path is ignored • Real-time impact of delay events when they occurred cannot be analyzed • Difficult to evaluate accelerations and mitigations • Usually only as-built critical path analyzed and near-critical paths are not considered • If multiple paths included in the analysis, each collapse measures only incremental delay to the critical path, because the completion date would not be preponed more than closest near-critical path.

4.1.4 Time Impact Method

In the Great Delay Analysis Debate (2006), time impact method was used on the delay scenario by the analyst who prepared the advice to the adjudicator for the Contractor's Claim. In this analysis, the effect of each delay event was analyzed chronologically taking into consideration the Contractor's progress between the occurrence of each event. To calculate the effect of each delay event, the program was updated with contemporaneous records up to the start date of the delay event and the updated project completion date was recorded. Next, activities representing the delay event were incorporated into the program and logic linked with the impacted activity to calculate the effect of the event on the project completion date. The delay time between the updated program and impacted program was attributed to the party responsible for the delay event. This process was repeated for each and every delay event identified by the analyst to calculate the Contractor's entitlement to extension of time.

The analysis conducted using the time impact method is explained step by step below.

- The first event that was taken into consideration by the analyst was Employer's verbal instruction to omit waterproofing finish. To calculate the effect of this instruction at the time it is given, the program was updated to the date instruction was received, which was 18-Mar-04. Figure 132 shows the updated program as of the end of 17-Mar-04 and the project completion date was postponed by 2 calendar days due to slow progress caused by bad weather, which is considered a contractor delay. Figure 133 shows the effect of omitting applied waterproofing at the time it was verbally instructed by the Employer. Since the duration of the Apply Waterproof Finish activity is set to 0 days, the project completion date was advanced by 5 working days. Hence, the forecasted project completion date was preponed by 4 calendar days compared to contractual date.

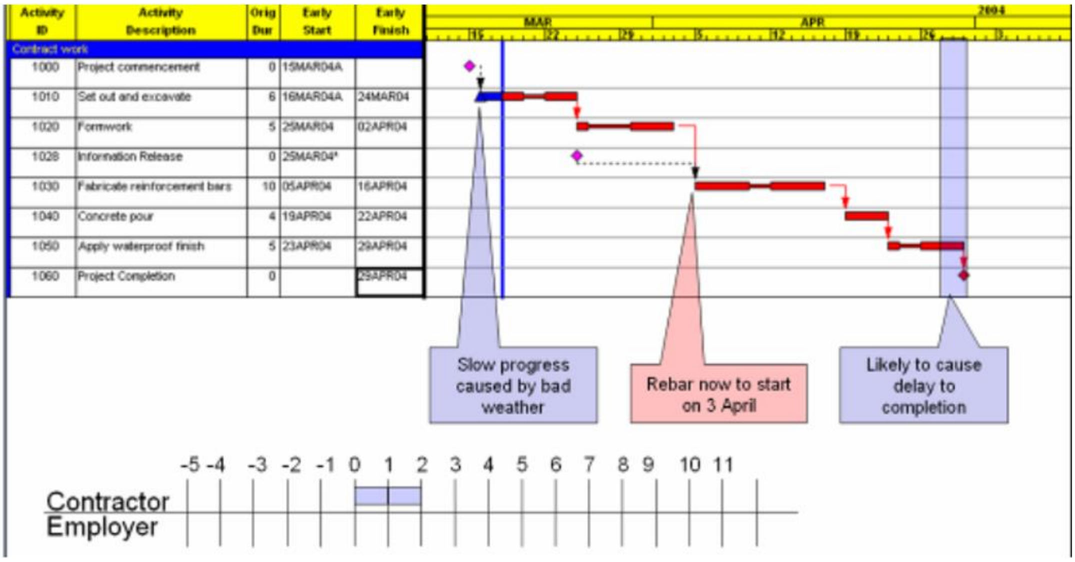


Figure 132 Time Impact Method – Updated Program Before Effect of Employer's Instruction to Omit Waterproof Finish

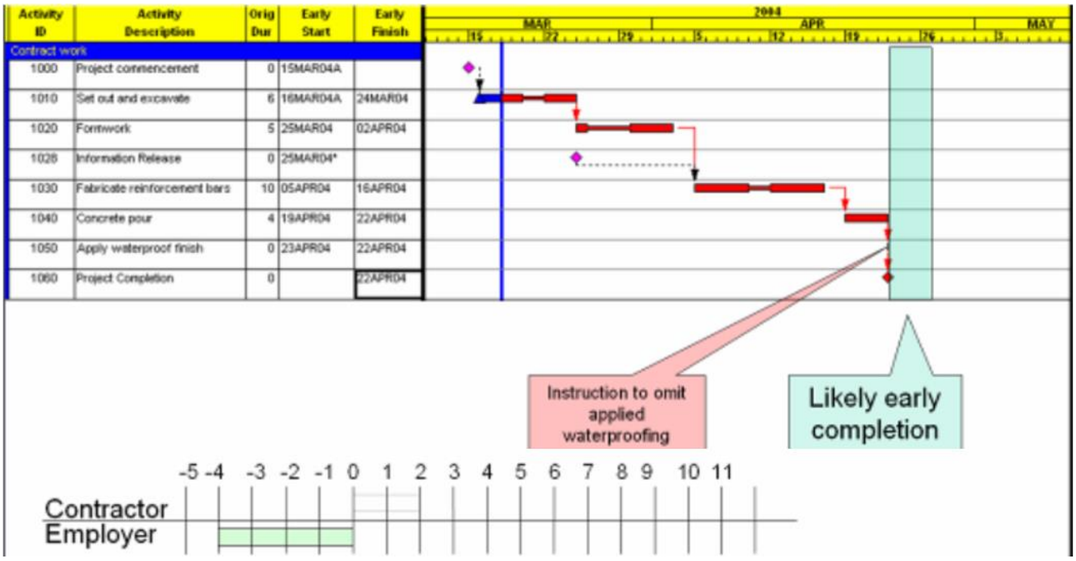


Figure 133 Time Impact Method – Effect of Omitting Apply Waterproof Finish

- The second event that was analyzed was the delay caused by setting out error due to mistake in slab drawing. Error in the setting out was realized on 23-Mar-04 by the Employer. Hence, the program was updated as of end of 22-Mar-04 to analyze the effect of the delay at the time it occurred as shown in Figure 134. It is illustrated that project completion date was delayed by 1 calendar day compared to latest update due to slow progress caused by bad weather on excavation. However, this delay did not cause any delay on project completion compared to contractual date, it has only reduced the available float from 4 calendar days to 3 calendar days. Figure 135 shows that the incorporation of effect of setting out error to the updated program, project completion date was shifted to 29-Apr-04 which is 2 calendar days later than contractual completion date. Since setting out error has occurred due to drawing provided by the Employer, the delay was attributed to the Employer.

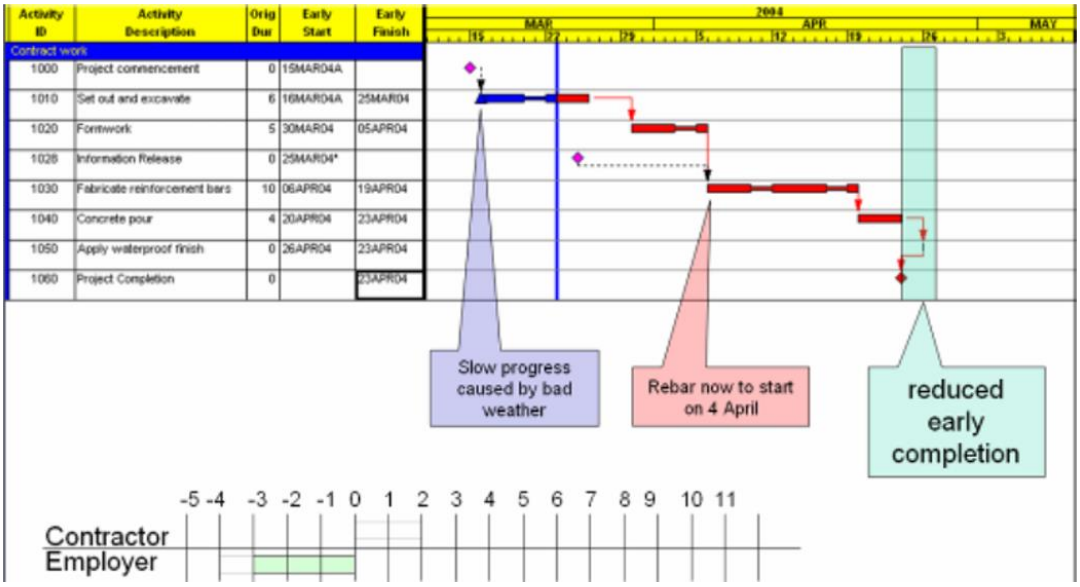


Figure 134 Time Impact Method – Updated Program Before Effect of Setting Out Error

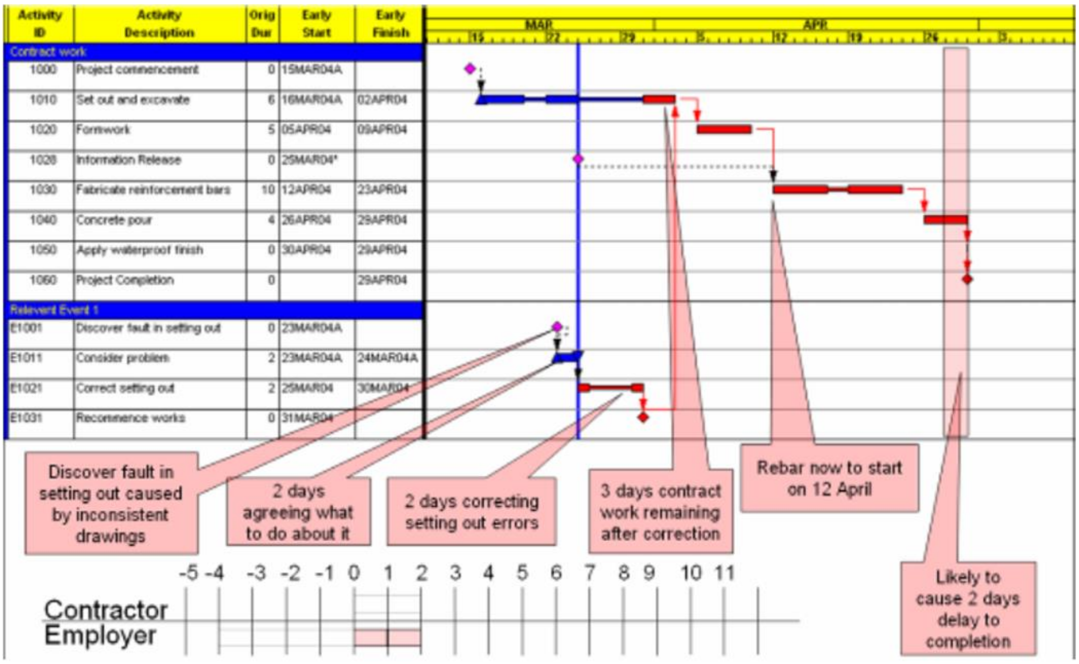


Figure 135 Time Impact Method – Effect of Setting Out Error

- The third event that was analyzed was delay of release of information related to rebar schedules by the Employer that was required to start Fabricate Reinforcement Bars activity. According to as-planned schedule, the information release should have been done on 25-Mar-04 however it was not done until 12-Apr-04. Figure 136 shows the effect of information release delay on project completion date by pushing the start date of fabricate reinforcement bar to 14-Apr-04 considering the lead time of rebar procurement which was reflected as a 2 days lag between relationship of Information Release and Fabricate Reinforcement Bars activities in the as-planned program. However, during the execution of the project, the Contractor anticipated the procurement of rebar that resulted as acceleration in the program. Hence, fabricate reinforcement bars activity has started on 12-Apr-04 immediately after completion of formwork and information release. Figure 137 shows the effect of accelerated procurement of rebars. The forecasted project completion date was calculated as 29-Apr-04, which is 2 calendar days later than contractual milestone.

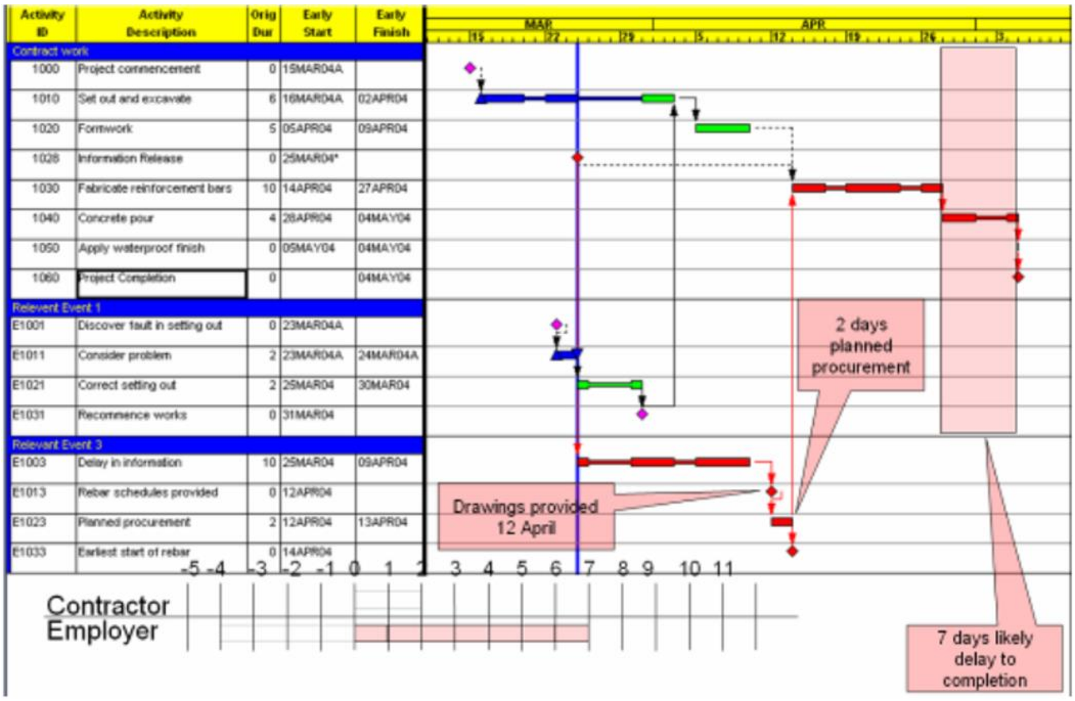


Figure 136 Time Impact Method – Effect of Information Release Delay

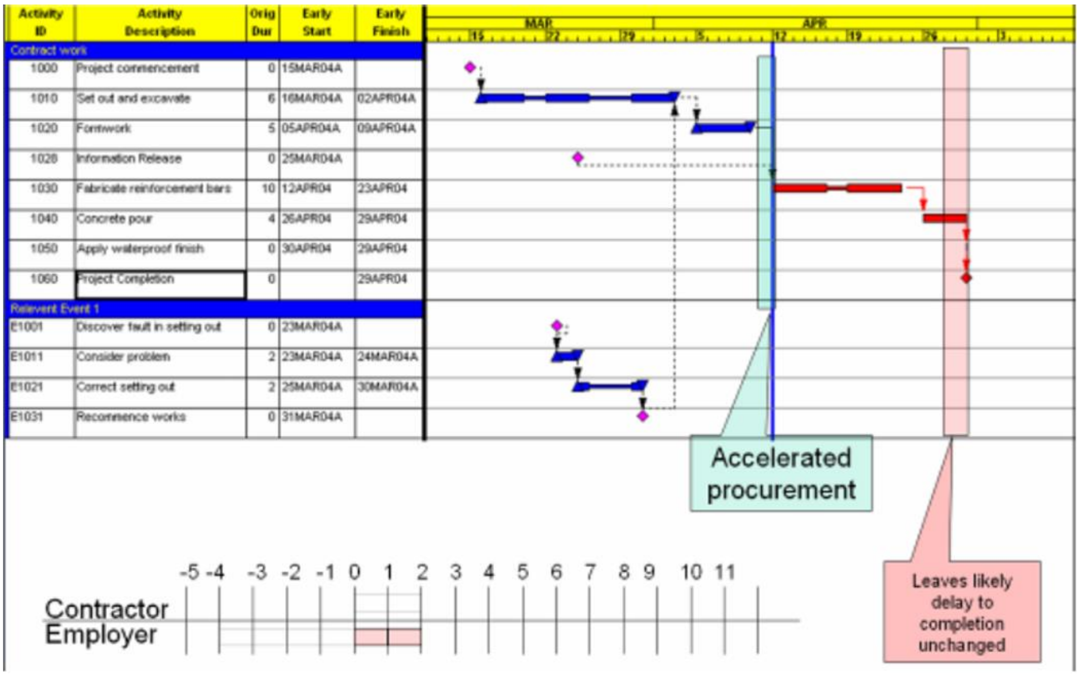


Figure 137 Time Impact Method – Effect of Accelerated Rebar Procurement

- The next event that was analyzed was related to Employer's instruction to use Admix in the concrete. The Employer gave the instruction to use Admix in the Concrete on 12-Apr-04 and Admix arrived at the site on 22-Apr-04. Figure 138 shows the effect of procurement of Admix based on updated program as of end of 11-Apr-04, which is the date delay event was started. The analyst concluded that by the time the Admix was ordered, the concreting activity for which it was required was not expected to commence until much later than the date on which it was delivered. Thus, the procurement of Admix had no effect on the project completion date. Furthermore, during the time in which the Admix was being procured, the Contractor accelerated the Fabrication Reinforcement Bars activity and this acceleration reduced the effect on the Project Completion milestone from 2 calendar days to 1 calendar day, as shown in Figure 139.

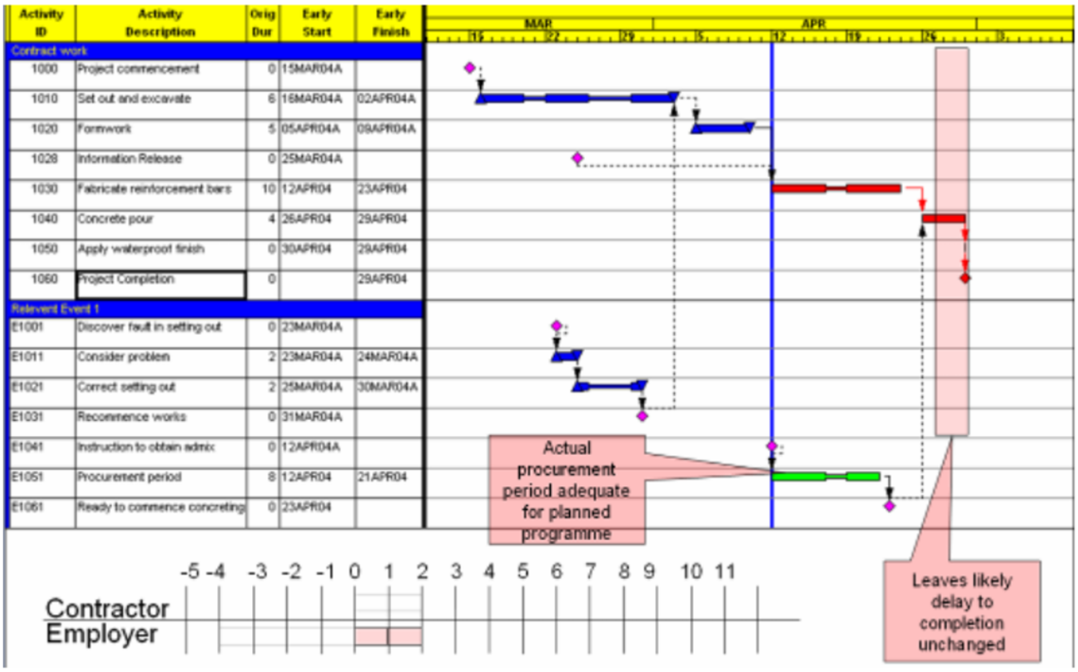


Figure 138 Time Impact Method – Effect of Procurement of Admix

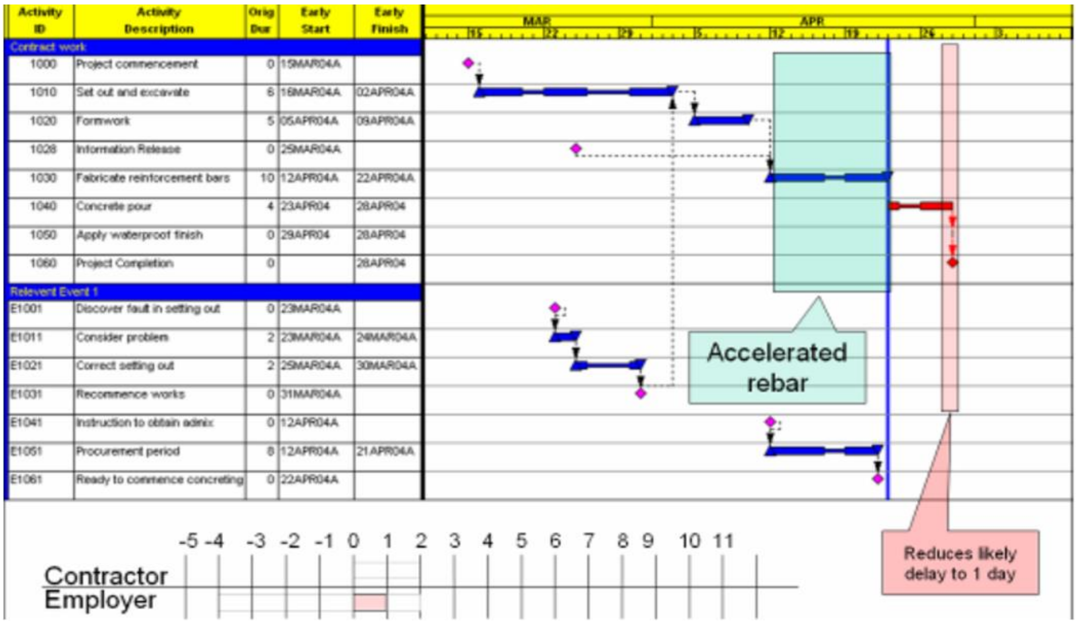


Figure 139 Time Impact Method – Effect of Accelerated Fabrication of Rebars

- The next delay event analyzed was related to delay in Concrete Pour activity. The Concrete Pour activity had an as-planned duration of 4 days. However, the change of scope that resulted in the inclusion of Admix into the concrete had caused lost productivity. Hence, the duration of Concrete Pour activity increased. According to the progress records, the Contractor made 16 concrete pours in total, and 3 pours were made at peak, which was considered as the baseline productivity rate. Hence, based on the determined baseline productivity, the duration in which the Contractor could complete the activity was calculated as 6 days. Hence, the delay event of additional time required due to Admix was added to the updated program to show the effect on the project completion milestone. As a result, the project completion date was shifted to 30-Apr-04, which is 3 days later than contractual date, as shown in Figure 140. Since the inclusion of Admix to the concrete was based on the Employer's instruction, the responsibility of the delay was attributed to the Employer. However, the Contractor used a total of 7 working days for Concrete Pour including a 1-working-day delay caused by lost productivity due to poor management. Figure 141 shows that the project was completed on 04-May-04, which is 7 calendar days later than contractual date. Even though there was a one-working-day delay on the Concrete Pour, the impact on project completion was 4 calendar days due to non-working days.

- In conclusion, the Contractor was entitled to an extension of time of 3 days and the Employer was entitled to apply liquidated damages of 4 days.

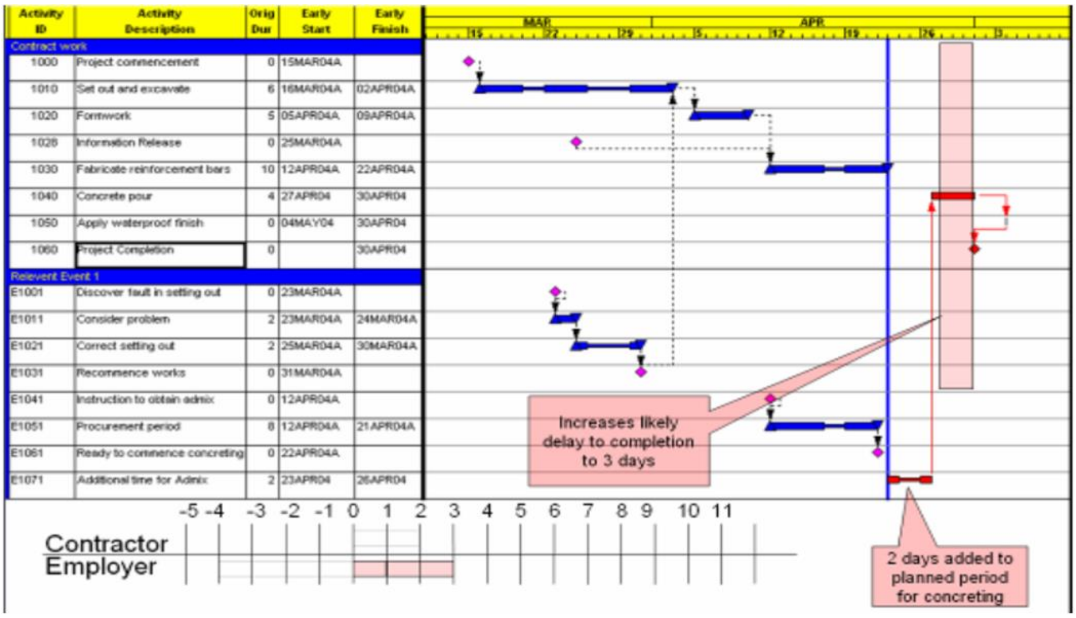


Figure 140 Time Impact Method – Effect of Additional Time Required for Admix

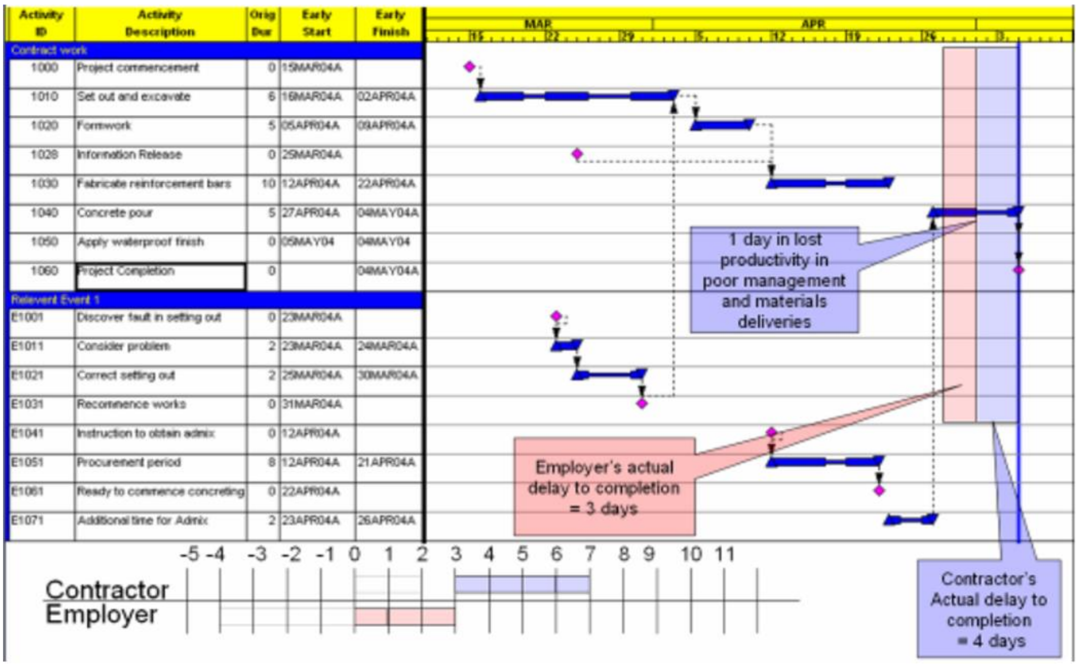


Figure 141 Time Impact Method – Effect of Lost Productivity due to Poor Management by the Contractor

Time impact is a cause-and-effect type of analysis method as it starts with the identification and description of delay causes and thereafter seeks to establish their effects on a contractual milestone by incorporating them into contemporaneously updated programs. As a result, the analysis often does not contain all the delay events that occurred in the project. Table 7 shows the comparison of delay events identified during performance of analyses of the TSWA method and the TIA method.

Table 7 Comparison of Delay Events in TSWA and TIA

Time Slice Windows Analysis	Time Impact Method
Non-Excusable - NED-1: Contractor's Low Progress	Non-Excusable - Slow Progress Caused by Bad Weather
Non-Excusable - NED-2: Contractor's Delay on Excavation Caused by Rain	Non-Excusable - Slow Progress Caused by Bad Weather
Non-Excusable - NED-3: Contractor's Delay on Excavation Caused by Rain	Not Included in the Analysis
Non-Excusable - NED-4: Rework Caused by Collapsed Excavation	Not Included in the Analysis
Compensable - CD-1: Additional Work Caused by Error in Setting Out	Compensable - Setting Out Error
Non-Excusable - NED-5: Contractor's Low Progress on Formwork Activity	Not Included in the Analysis
Compensable - CD-2: Delay in Rebar Schedules Release	Compensable - Delay in Information Release
Compensable - CD-3: Procure of Admix Caused by Employer Instruction	Compensable - Procurement of Admix
Non-Excusable - NED-6: Contractor's Low Progress on Fabrication Rebars	Not Included in the Analysis
Non-Excusable - NED-7: Contractor's Low Progress on Concrete Pour Activity	Non-Excusable - Lost Productivity due to Poor Management by the Contractor

The first event that was analyzed was related to Employer's verbal instruction to omit waterproof finish in the time impact analysis. Due to the omitting of waterproof finish, the forecasted project completion date was preponed by 4 calendar days compared to the as-planned program. However, since the full effect of this decision was not known when this verbal instruction was received on 18-Mar-04, omission of waterproof finish activity was only done when the Employer's formal instruction received on 12-Apr-04 regarding the use of Admix in concrete rather than waterproof finish in the time slice windows analysis. Even though it was known that there would be an additional effect on the program after the Employer's decision on which waterproofing method was to be used, the analyst decided to omit waterproof activity which would show an unrealistic forecasted project completion date. Due to this difference between the time slice windows analysis and time impact analysis performed on the delay scenario, results of updated programs as of end of 17-Mar-04 were different. The forecasted project completion date in the updated program as of end of 17-Mar-04 was 22-Apr-04 in time impact analysis and it was 30-Apr-04 in Window 3, which is the window as of end of 17-Mar-04, of time slice windows analysis. This is evidence that the analyst's interpretation of the timing of the inclusion of events to the analysis may have a significant impact on the result of the analysis. However, this difference in incorporation of timing of acceleration did not cause a difference in the end result of the analyses because the float created by this acceleration would be consumed by both Contractor and Employer with a concurrent delay without creating any additional benefit to one party in the time slice windows analysis even if the omission of waterproofing activity was done on the updated program as of end of 17-Mar-04.

As shown in Figure 134, there was a one-day delay on the updated program before the effect of setting out error compared to the previous update. However, since there was total float available in the project, this delay event only reduced the total float available on the critical path. Hence, this delay was not categorized as a critical delay. As evidenced by this example, time impact analysis can assess the effects of delays at the time they occur, and it can analyze whether or not a delay is a critical one.

Since time impact analysis is a cause-and-effect type of analysis, some delay causes may not be included in the analysis by the analyst, which makes the method relatively easy to manipulate. The dominant delay that affected the progress of Set Out & Excavate activity was caused by NED-4: Rework Caused by Collapsed Excavation delay event. The result of Window 15, when Set Out & Excavate activity was completed, shows that there were 14 calendar days of critical delay in the path Set Out & Excavate to Project Completion. Ten out of 14 days of this critical delay were concurrently caused by NED-4: Rework Caused by Collapsed Excavation and CD-1: Additional Work Caused by Error in Setting Out, and the remaining 4 days of this critical delay were solely caused by NED-4: Rework Caused by Collapsed Excavation delay event. However, the delay caused by the collapsed excavation, which was the dominant delay that affected Set Out & Excavate activity, was not included into the time impact analysis. Due to that, even though final result of time slice windows analysis shows 3 days of excusable delay caused by concurrency of compensable and non-excusable delays, the time impact analysis shows only 3 days of Employer delay which is compensable delay.

The delay event related to information release was added to the updated program as of end of 24-Mar-04, because as-planned date of information release was 25-Mar-04. As shown in Figure 136, the critical path of the project was changed from Set Out & Excavate to Project Completion path to Information Release to Project Completion path as the actual release of information was on 12-Apr-04. However, as explained in time slice windows analysis, information release had not become on the critical path of the project until Window 18, which was updated in the program as of end of 11-Apr-04. The difference between the timing of critical path change is that time impact analysis calculates the impact of delay prospectively, and time slice windows analysis calculates the impact of delay retrospectively. Thus, time impact analysis produces theoretical results as it provides the consequences of an event on the assumption that future activities of the program will proceed as planned. In addition, due to impact of delays are added to the program prospectively, it may hide some concurrent delays that occurred between two update periods. For instance, as explained in Window 19 of time slice windows analysis, both Formwork and Information Release activities had driven the start date of fabrication reinforcement bars. So that, it was reported that there was concurrent delay in Set Out & Excavate activity which was delayed due to dominant delay caused by collapsed excavation. However, since the impact of information release delay was included to the updated program prospectively, the effect of this concurrent delay was missed in the time impact analysis. Hence, even though it is possible to detect concurrent delay in time impact analysis as it takes into account both Employer and Contractor delays, it is difficult to recognize them in some cases where a concurrent delay is overlooked due to prospective effect of another delay event.

As shown in Figure 137 and Figure 139, accelerations can be recognized in time impact analysis. However, the acceleration that has been done in Formwork activity was recognized in time slice windows analysis, which was explained in Window 18 and 19. However, it was not recognized in the time impact analysis due to the fact that events that affected Set Out & Excavate and Formwork activities were hidden by the prospective impact of delay of information release. Hence, even though it is possible to detect accelerations and mitigations in time impact analysis as the programs are updated with contemporaneous information during the analysis, it is difficult to recognize them in some cases where effects of events in a path may be overlooked due to prospective effect of another delay event.

Effect of Employer's instruction of inclusion of admix to the concrete instead of waterproofing was included into the analysis in two different phases in time impact analysis. The delay event related to procurement of admix was included into the updated program as of end of 11-Apr-04, as Employer's instruction was received on 12-Apr-04. Since Admix was delivered on 22-Apr-04 and Concrete Pour was forecasted to start on 26-Apr-04 in the updated program as of end of 11-Apr-04, it was concluded that delivery of admix had no effect on project completion milestone. Actually, the Admix was only delivered just before Concrete Pour activity start which makes it on the as-built critical path of the project. This delay impact was also missed in time impact analysis because it makes assessment of delays prospectively.

The second delay event caused by Employer's instruction was lost productivity caused by inclusion of Admix in the Concrete Pour activity. In time impact analysis, effect of lost productivity caused by inclusion of Admix in the Concrete Pour activity was assessed on the updated program as of end of 22-Apr-23, as Concrete Pour activity was started on 23-Apr-23. The delay on project completion milestone was reported as 3 days in the time impact analysis as shown in Figure 140. Window 29 of time slice windows analysis, in which updated program as of end of 22-Apr-23 was considered, also shows 3 days effect on the project completion date. The main difference is that in time slice windows analysis the concurrent delays are also identified but in time impact analysis these concurrent delay events were not recognized due to shortcomings of the method as explained in detail before.

The last delay event on the project was caused by Contractor in Concrete Pour activity which pushed the finish date of Concrete Pour by one working day. However, the effect of this delay was resulted in 4 calendar days shift in Project Completion milestone due to non-working days.

In conclusion, in terms of entitlement to extension of time, both methods provided the same result that the Contractor is entitled to receive 3 days extension of time. However, as SCL (2017) recommends that when there is concurrent contractor and employer delay, the contractor is entitled to receive extension of time but is not entitled to be compensated for the prolongation costs. Hence, according to time impact analysis results, the Contractor is entitled to be compensated for 3 days prolongation costs as concurrent delay was failed to be recognized. However, according to time slice windows analysis results, the Contractor is not entitled to be compensated for prolongation costs because there are also non-excusable delays that are concurrent to the compensable delay up to 30-Apr-04 as shown in final results of the analysis at Figure 123.

The strengths and weaknesses of the time impact method are summarized in Table 8 based on the discussion and comparison of results of the time impact method on the delay scenario with time slice windows analysis performed in this thesis.

Table 8 Strengths and Weaknesses of Time Impact Method

Strenghts	Weaknesses
• Performed contemporaneously, considers contemporaneous intentions • Real-time impact of delay events when they occurred can be analyzed • Considers both contractor and employer delays • Concurrency can be detected to some extent • Accelerations and mitigations can be detected to some extent • Considers changes in the critical path • Considers program logic changes • Has a systematic approach and structured methodology • Effect of each delay event is individually evaluated • Total float consumption can be tracked • Can identify the period of the critical delay for prolongation costs calculation	• Produces theoretical results • Relatively easy to manipulate the results • Difficult to recognize concurrent delay • Difficult to recognize accelerations and mitigations • Requires contemporaneously updated programs • Time consuming and expensive to perform • Requires detailed as-built record keeping

4.2 Time Slice Windows Analysis

The basic idea of this technique is to divide total project duration into shorter time periods, called windows, and update the program at the end of each window according to achieved progress and contemporaneous intentions to find the effect on a contractual milestone. Afterwards, identify the delayed activities and establish the causation from as-built records. In this thesis, daily windows are selected to have greater sensitivity in the analysis. Table 9 shows the evidence from the performed time slice windows analysis on the case study project that the method can detect important aspects related to delay analysis such as concurrent delays, accelerations, changes in the critical path and so on.

Time slice windows analysis forces the analyst to consider actual progress and contemporaneous intentions in a logical and chronological manner. It is difficult to manipulate the results of the analysis because effects on milestones are calculated based on contemporaneous update of the program as a first step and then delay causes are derived from as-built records. It was not possible to make a manipulation of a delay cause during the performance of time slice windows analysis on the case study project. The program was updated each day according to progress records and was observed that whether there was any delay to progress or not. If there was a delay to progress, then a delay cause from the same date had to be attributed to the delay. Thus, it was not possible to make a manipulation on the delay causes. However, the sensitivity of the analysis would be reduced if bigger window sizes had been used in the analysis. For instance, if window sizes were 15 days, then there would be only one window between Window 1 and 15. Hence, in the first window Set Out & Excavate activity would be completed. Even though the effect of the delay of Set Out & Excavate activity would be same, concurrent delays that had happened on the activity might not be detected and only the dominant delay cause which was collapse of the excavation might be reported. In addition to that, the critical path change that occurred in Window 18 would not have been realized due to the window sizes, as the critical path was shifted once again in Window 19.

Table 9 Evidences From Performed Time Slice Windows Analysis That It Can Deal With Important Issues in Delay Analysis

Issues in Delay Analysis	Evidence That TSWA Can Deal With The Issues
Concurrent Delay or Concurrent Effect	Window 7 to 36
Acceleration	Window 18, 19, 24, 25 and 36
Change in Critical Path	Window 18 and 19
Change in Program Logic	Window 19
Multiple Critical Paths	Window 19 to 36
Effect of Variation Order or Scope Change	Window 19 to 29
Effect of Nonworking Days	Window 4, 10, 12 ,16, 19, 25 and 30 30

Time slice windows analysis measures the real-time impact of delays when they occurred taking into consideration the contemporaneous intentions at the time. The effects of delay events are evaluated retrospectively, and the critical and near-critical paths are determined contemporaneously. Hence, a change in a critical path can be identified as the program is updated continuously based on the determined window size with actual progress until the last window which becomes the as-built schedule. Hence, the result of this analysis is not merely a theoretical one since it results in as-built schedule that demonstrates the actual effects of delays.

If the as-planned program contains logical errors, the errors will be corrected while program is being updated contemporaneously during the analysis, as the logic of the updated program should be revised based on the actual work sequence. However, these corrections of logical errors may result in an additional delay on milestones due to the change of plan for the remaining work caused by these corrections. Thus, it is crucial to verify the reasonableness and achievability of the as-planned or updated programs before starting the time slice windows analysis.

The period of the critical delay can be identified, as the effects of delays are measured in the windows. It is required to know the period of critical delay to understand what the timing of the prolongation in the project is. The time-related costs will be higher if the critical delay occurred during the peak time of the project, as more resources were deployed at that time. Hence, prolongation costs must be calculated according to the period of critical delay.

Based on the above discussion and examples from time slice windows analysis conducted for the case study project in this thesis, the strengths and weaknesses of the method are summarized in Table 10.

Time slice windows analysis is not only a delay analysis method, but also an important method to be used for better project and contract management. Delay and Disruption Protocol of SCL (2017) discourages the wait-and-see approach regarding impact of delay events and suggests that applications for an extension of time should be made and dealt with as close in time as possible to the delay event that gives rise to the application. This approach requires contemporaneous delay analysis during project execution. In addition, dealing with delay matters during the project will prevent the piling up of the delays and would help to avoid disputes between the parties. Furthermore, contemporaneous analysis of delays would be beneficial to identify the measures that can be taken by both Contractor and Employer to eliminate the effects of delays. Moreover, most of the standard forms of contract, such as FIDIC, have a clause related to the notification requirement of delays. If the timeline stipulated in the contract related to the notification of delays is not respected, the Contractor loses its right to claim. To notify delays on time, the Contractor needs to be able to identify delays at the time of their occurrence. Utilizing contemporaneous delay analysis technique during project execution would facilitate the identification of delays and their effects at the time they occur. It is also crucial to request extension of time from the Employer at the time the delay occurs to be able to claim costs of constructive acceleration from the Employer in case a rightful extension of time claim is rejected by the Employer.

Table 10 Strengths and Weaknesses of Time Slice Windows Analysis Method

Strenghts	Weaknesses
• Performed contemporaneously, considers contemporaneous intentions • Demonstrates actual effects of delays rather than theoretical results • Real-time impact of delay events when they occurred can be analyzed • Difficult to manipulate the results • Considers both contractor and employer delays • Concurrent delays can be identified • Accelerations and mitigations can be identified • Considers changes in the critical path • Considers program logic changes • Allows identification of multiple critical paths • Has a systematic approach and structured methodology • Effect of each delay events can be individually evaluated • Total float consumption can be tracked • Can identify the period of the critical delay for prolongation costs calculation	• Requires contemporanulsy updated programs • Time consuming and expensive to perform • Requires detailed as-built record keeping • Requires verification of reasonableness and achievability of the program logic • Sensitivity of the analysis changes according to window size

Below are some examples that explain what the advantages would be of using time slice windows analysis during the case study project for the Contractor.

- The Contractor would identify the concurrent delay that occurred on Set Out & Excavate activity due to setting out error in Window 7 and then notify the Customer of the delay to start the claim process. Later in Window 13, once the effect of the setting out error on the activity was finished, the Contractor could request extension of time based on the contemporaneously updated schedule.
- The Contractor would identify the critical path change to the path from Information Release to Project Completion due to Employer's delay in providing required information in Window 18 and may choose not to accelerate the rebar procurement to keep the Employer's delay on the critical path and claim the entitled extension of time.
- The Contractor would be able to estimate the effect of Employer's instruction to use Admix in the concrete instead of waterproof finish on the updated program. Hence, the Contractor could use this opportunity to sign a variation order with the Employer including EOT entitled at the end of Window 19.
- The contractor worked on non-working days to accelerate the Fabricate Reinforcement Bars activity, as explained in Window 24 and 25. As a result of this acceleration, the forecasted project completion date was preponed from 05-May-04 to 29-Apr-04, which was an acceleration of 6 calendar days. As can be seen from Window 23, before this acceleration decision there was not only a non-excusable delay affecting the critical path but also a concurrent compensable delay that had the same effect on the project completion date. If the Contractor had used the time slice windows analysis during the project execution, it would have been able to claim extension of time for 8 days at the end of Window 23. If the claim had been rejected by the Employer, the Contractor's acceleration would have been constructive acceleration. Hence, the Contractor would be entitled to claim the costs of acceleration from the Employer.

- According to the results of Window 29, which was the updated program just before Concrete Pour activity start, the Contractor was entitled to receive 3 days extension of time because of the concurrent delays caused by the Customer. Due to that, it was crucial to be on time with the Concrete Pour activity to avoid being exposed to liquidated damages. Thus, if the Contractor had used time slice windows analysis during the project execution, it would have known that being on time with the Concrete Pour activity was crucial. However, the Contractor had a working-day delay in Concrete Pour activity. Furthermore, the Contractor did not work on non-working days to minimize the impact and the delay on the project completion date became 4 calendar days. If the Contractor had performed this analysis, it would have at least decided to work on a non-working day to keep the delay as 1 calendar day instead of 4 calendar days.

4.3 Findings from Comparison of Delay Analysis Methods

Table 11 shows the strengths and weaknesses of commonly used delay analysis methods based on the comparison made between the results of the delay analysis methodologies on the same delay scenario.

It is believed that this thesis contributes to the literature as follows:

- In the literature, it is observed that some researchers performed multiple delay analyses methods on delay scenarios to compare the results (Bubshait & Cunningham, 1998; Farrow, 2007; Kao & Yang, 2009; Al-Gahtani & Mohan, 2011). However, delay scenarios used in their researches were simple, had pre-determined delay events and did not address complex situations. In this thesis, strengths and weaknesses of commonly used delay analysis methods are derived from a relatively complex delay scenario by comparing the results of their analyses. The delay scenario used in this thesis contains complex situations such as identification of delay events from as-built records, concurrent delays, accelerations, changes in critical path, changes in network logic, identification of multiple critical paths, variation orders and so on. Hence, each method's ability to detect these complex situations is tested and results of analyses are compared to identify strengths and weaknesses of each method.

- In the literature, it is observed that time impact analysis is considered to be most effective method in proving time-based claims (Baram, 1994; Alkass et al., 1996; Gothand, 2003; Arditi & Pattanakitchamroon, 2006; SCL, 2006; SCL 2017). However, some major weaknesses of TIA were detected while comparing the results of TIA and TSWA on the delay scenario. TIA takes into account the progress made in the project before analyzing the effect of a delay event by both contractor and employer. Hence, the method can detect concurrency, accelerations, mitigations, critical path changes, and program logic changes. However, in some cases, it may overlook these important issues, because the effects of selected delay events are incorporated into the program, which is updated up to the start date of the delay event, prospectively. Thus, effects of a concurrent delay, acceleration or logic change that have occurred on another path or during different time periods of the same path might not be identified if a delay event has not been included in the analysis. Furthermore, a delay event that had never caused critical delay during the execution of the project might be considered as critical in the TIA due to prospective effect of the delay event.
- It is identified that TSWA does not have the weaknesses of other commonly used delay analysis methods. Furthermore, TSWA is not only a delay analysis method, but also a key method for improved project and contract management during the execution of a project. Contemporenous analysis of delays would facilitate contractors on compliance with delay notification requirments of contracts, mitigation of effects of delays, issuance of EOT claims in due time, avoidance of disputes and so on.

Table 11 Strengths and Weaknesses of Delay Analysis Methods

Strengths / Weaknesses of Delay Analysis Methods	IAP	APvsAB	CAB	TIA	TSWA
Strengths					
• Methodology is easy to understand	+	+	-	-	-
• Does not require as-planned program	-	-	+	-	-
• Does not require as-built program	+	-	-	+	+
• Does not require contemporaneously updated programs	+	+	+	-	-
• Does not require program created with CPM	-	+	-	-	-
• Does not require analysis of all delay events	+	+	+	+	-
• Has an analytical methodology	+	-	+	+	+
• Effect of each delay event is individually evaluated	+	-	+	+	+
• Considers both contractor and employer delays	±	+	±	±	+
• Fact based analysis	-	+	+	±	+
• Demonstrates actual effects of delays rather than theoretical results	-	+	-	-	+
• Performed contemporaneously, considers contemporaneous intentions	-	-	-	+	+
• Real-time impacts (at the time) of delay events can be analyzed	-	-	-	+	+
• Difficult to manipulate the results	-	±	-	±	+
• Critical path changes can be identified	-	-	-	±	+
• Accelerations can be identified	-	±	±	±	+
• Concurrent delays can be identified	-	±	-	±	+
• Program logic changes are considered	-	-	-	+	+

Table 11 Strengths and Weaknesses of Delay Analysis Methods (continued)

• Total float consumption can be tracked	-	-	-	+	+
• Allows identification of multiple critical paths	+	-	±	+	+
• Period of the critical delay for prolongation costs calculation can be identified	-	-	-	+	+
• Can be used for improved project and contract management during the execution of a project	-	-	-	±	+
Weaknesses					
• Relies on as-planned logic and durations	×	-	-	±	-
• Requires detailed as-built record-keeping	-	×	×	×	×
• Time consuming and expensive to perform	-	-	×	×	×
• Requires creation of logic linked as-built program	-	-	×	-	-
• Does not follow a structured methodology	-	×	-	-	-
• Evaluates the net impact of delays rather than analyzing impact of individual delay events	-	×	-	-	-
• Concentrates only on delays of other party	×	-	×	-	-
• Only selected delay events are analyzed	×	-	×	×	-
• Produces theoretical results	×	-	×	±	-
• Real-time impacts (at the time) of delay events cannot be analyzed	×	×	×	-	-
• Easy to manipulate the results	×	±	×	±	-
• Cannot analyze if as-built logic altered from as-planned logic during execution	×	×	-	-	-
• Critical path changes cannot be identified	×	×	×	±	-
• Accelerations cannot be identified	×	±	±	±	-
• Concurrent delays cannot be identified	×	±	×	±	-
• Program logic changes are ignored	×	×	×	-	-

Table 11 Strengths and Weaknesses of Delay Analysis Methods (continued)

• Cannot identify delays caused by loss of productivity	×	±	×	±	-
• Only critical path analyzed, and near-critical paths are not considered	-	±	±	-	-
• Not suitable for complex and large-scale projects	×	×	-	-	-
• Sensitivity of the analysis changes according to window size	-	-	-	×	×

Note: (+) = The method contains the strength, (-): The method does not contain the strength or weakness, (×): The method contains the weakness, (±): The method contains the strength or weakness in some cases

CHAPTER 5

CONCLUSION

Delays are inevitable in construction projects and have major financial consequences such as prolongation costs and liquidated damages to contractors or delayed operational profit to employers. Apportionment of responsibility of delays between contractor and employer is of prime importance to define which party should compensate the financial losses. Thus, delay analysis methods have been developed to provide an answer to the question of which party caused the delay. However, each method requires the performance of different types of data and may yield different results when performed on the same case. The delay analysis methods frequently used in the construction industry include impacted as-planned, as-planned vs. as-built, collapsed as-built, time impact analysis and time slice windows analysis.

SCL (2006) analyzed a delay scenario using impacted as-planned, as-planned vs. as-built, collapsed as-built, and time impact analysis. In this thesis, the same delay scenario was analyzed using time slice windows analysis. The results of time slice windows analysis were compared with the results of other methods. Considering the comparison made among the results of the delay analysis methodologies on the delay scenario, the strengths and weaknesses of each method were identified.

The impacted as-planned method appears to be the simplest method of delay analysis as it is conducted by merely inserting selected delay events to the as-planned program. However, the method does not yield reliable results as it ignores what actually occurred and focuses on what might have happened. Hence, the method produces theoretical results and may even result in a different project completion date than the actual completion date. Moreover, it cannot identify any of the important issues in delay analysis such as change in critical path, concurrent delays, acceleration, mitigation and so on. The method can only give reliable results when there is a delay to the start date of a phase of the project, such as a delay in the contractual commencement date or site access.

The as-planned vs. as-built method is also one of the delay analysis methods that is simple to perform. It does not even require a CPM schedule to be performed. The method includes a simple comparison of as-planned and as-built programs to define what has caused the delay. It can consider both contractor and employer delays, and it can detect concurrent delays to some extent. However, the method does not have a structured methodology by which to calculate the effects of each delay separately. Thus, it is recommended that as-planned vs. as-built method is better to be used as a starting point, before implementing a complex method, to understand the principal characteristics of the matter.

The collapsed as-built method can be used when there is no as-planned program. However, it is also a subjective method as it includes the creation of an as-built program from the records. As-built linkage can be easily manipulated to suit the claimant's case because records on the as-built relationship between activities are never kept. The method focuses on a static critical path as if there were no changes on the critical path during project execution. In addition to that, usually only a single critical path is analyzed and near-critical paths are ignored, which makes it impossible to identify concurrent delays.

The time impact analysis method does not contain most of the weaknesses of impacted as-planned, as-planned vs. as-built, or collapsed as-built methods. However, as a complex method it requires extensive contemporaneous records and significant effort and time to be performed. It is also a prospective method as is the impacted as-planned method, but it takes into account the progress made in the project before analyzing the effect of a delay event by both contractor and employer. Hence, the method can detect concurrency, accelerations, mitigations, critical path changes, and program logic changes. However, in some cases, it may overlook concurrency, accelerations, critical path changes and so on, because the impact of selected delay events are incorporated into the program, which is updated up to the start date of the delay event, prospectively. Thus, effects of a concurrent delay or acceleration that have occurred on another path might not be identified if a delay event has not been included in the analysis even though the effect of the delay event that has occurred on another path would be noticed by the analyst in the next updated program. As the method is a cause-and-effect method and effects of selected delay events are analyzed, it is subject to manipulation even though it is harder to manipulate than the impacted as-planned and collapsed as-built methods.

According to the results of comparison of delay analysis methods based on the delay scenario, time slice windows analysis is the method that yields more reliable results than the others. It is an effect-and-cause type of method that starts with the identification of the effect of delays on a contractual milestone and then seeks to determine what might have caused the delay. Since this process is done in time windows, it is difficult to manipulate the cause of the delay that occurred. Furthermore, the method can identify concurrent delays, changes in critical path, accelerations, mitigations, total float consumption, effect of variation orders, the real-time impact of delays at the time they occurred, and so on. However, it is time-consuming to perform and it requires detailed as-built records and contemporaneously updated programs. Additionally, the sensitivity of the analysis decreases when longer window sizes are selected because critical path changes, accelerations, or productivity losses may not be noticed within the window, as the effects of all the events can only be seen at the end of the window time.

The best practice is to perform time slice windows analysis is during the project execution not only to satisfy the requirement of keeping of as-built records and contemporaneous update programs, but also to reap its additional benefits in terms of project and contract management. Contractors can issue their extension of time claims during the project to settle their claims without waiting for the project to actually be delayed, which also facilitates the compliance of delay notification clauses in contracts. Furthermore, contemporaneous analysis of delays would be beneficial to identify the measures that can be taken by both the contractor and employer to eliminate the effects of delays.

Various delay analysis methods utilized in the construction sector employ diverse techniques to assess delays and disruptions and determine their consequences. There is no single favored delay analysis approach that is applicable in all situations. Despite certain methodologies being considered more reliable than others, industry experts struggle to reach a consensus on the most effective practices.

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