CENG 6101 Project Management

Change Management

Abraham Assefa Tsehayae, PhD

Change Management

Change Management

Owner Events

- Lack of site possession/ handing over site to contractor
- Providing Notice to Proceed
- Late approvals or instructions
- Changes in design/materials/specification
- Delayed payments

Contractor Events

- Contractor design omissions and deficiencies
- Defective procured items
- Delayed performance (various causes attributable to contractor)
- Excessive cost (if contract price is not fixed)

Third Party Events

- Adverse site conditions
- Adverse weather
- Strikes
- Working in hostile areas

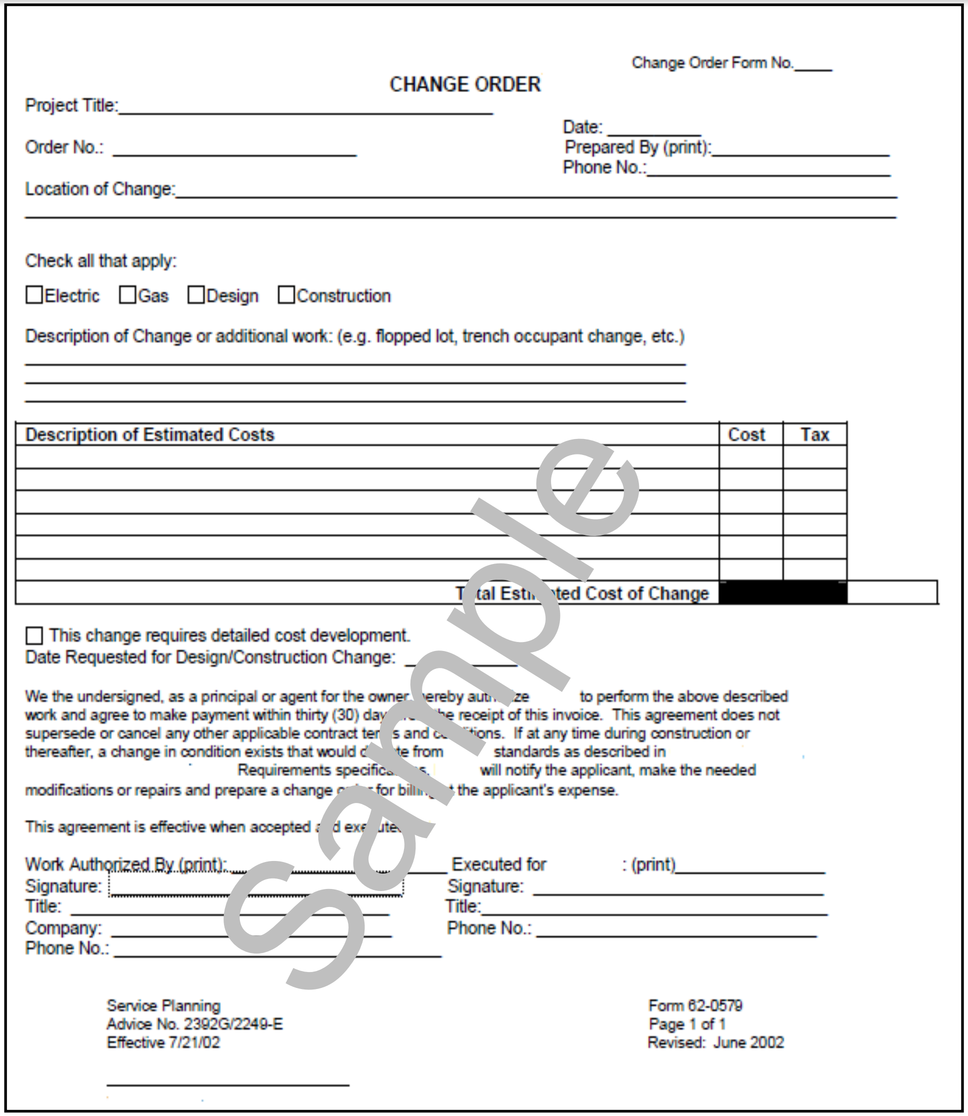
Change Management

- Changes may lead to cost overruns or cost savings, time extension or time savings

Change Order

1. For any changes to the scope of work, a written document of the change – called a change order - is submitted. This document is to verify and attain that a change to the original contract has occurred, and accordingly, time and cost implications might occur
2. Change orders are written for:
   - Alterations to the original scope of work
   - Increasing or decreasing the contract quantities
3. Change orders state the basis and amount of payment and time extension entitlement, and hence, the basis of a claim:
   - Unresolved change order = Claim

Change Order Form



Change Order Form No.____

CHANGE ORDER

Project Title:________________________________

Order No.: ____________________

Date: __________
Prepared By (print):________________
Phone No.:_____________________

Location of Change:____

Check all that apply:

☐Electric ☐Gas ☐Design ☐Construction

Description of Change or additional work: (e.g. flopped lot, trench occupant change, etc.)

Description of Estimated Costs	Cost	Tax
T tal Esti ted Cost of Change		

☐ This change requires detailed cost development.
Date Requested for Design/Construction Change: __________

We the undersigned, as a principal or agent for the owner ereby auth ze to perform the above described work and agree to make payment within thirty (30) day he receipt of this invoice. This agreement does not supersede or cancel any other applicable contract ter s and c itions. If at any time during construction or thereafter, a change in condition exists that would d te from standards as described in Requirements specifica s, will notify the applicant, make the needed modifications or repairs and prepare a change o for billing t the applicant's expense.

This agreement is effective when accepted d exe ute

Work Authorized By (print):____________________ Executed for : (print)______________
Signature: ____________________ Signature: ____________________
Title: ____________________ Title:____________________
Company: ____________________ Phone No.: ____________________
Phone No.: ____________________

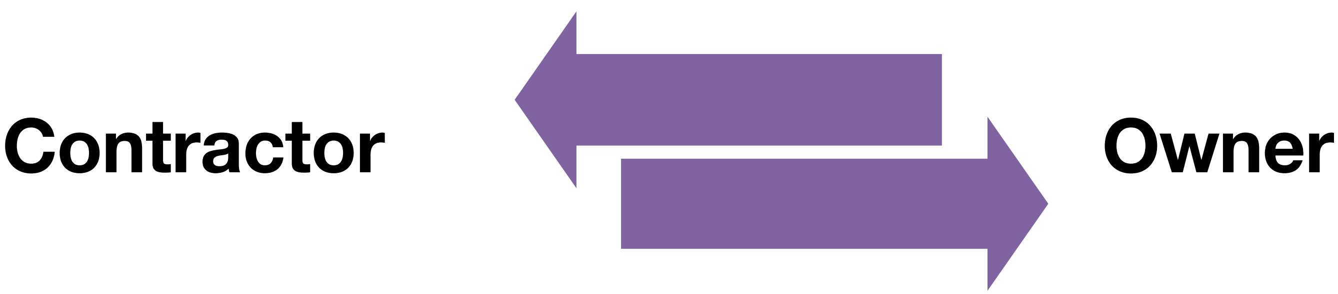
Service Planning
Advice No. 2392G/2249-E
Effective 7/21/02

Form 62-0579
Page 1 of 1
Revised: June 2002

Claims in the Construction Domain

- A claim is an unresolved request submitted by the contractor for additional compensation for occurrences beyond his/her control
- "A claim is a demand, right or request for something rightfully or allegedly due"

Rubin, R.A., et al. (1992). *Construction Claims Prevention and Resolution*, 2nd Ed., Van Nostrand Reinhold, New York.



Claims Flow Path

Claims in the Construction Domain

Causes:

1. Owner changes
2. Design errors/omissions
3. Wrong specifications
4. Non performance/contractor errors
5. Weather…etc

Claims in the Construction Domain

Categories of Claims

1.Delays	2.Disruption	3.Changed Conditions	4.Scope Changes	5.Termination
Late drawings, lack of access to site,…etc	Client change orders, other contractors' delays,…etc	Actual job conditions are different from those described in contract documents	Changes after the contract is signed	Contract being terminated before work is completed

Impact of Construction Claims

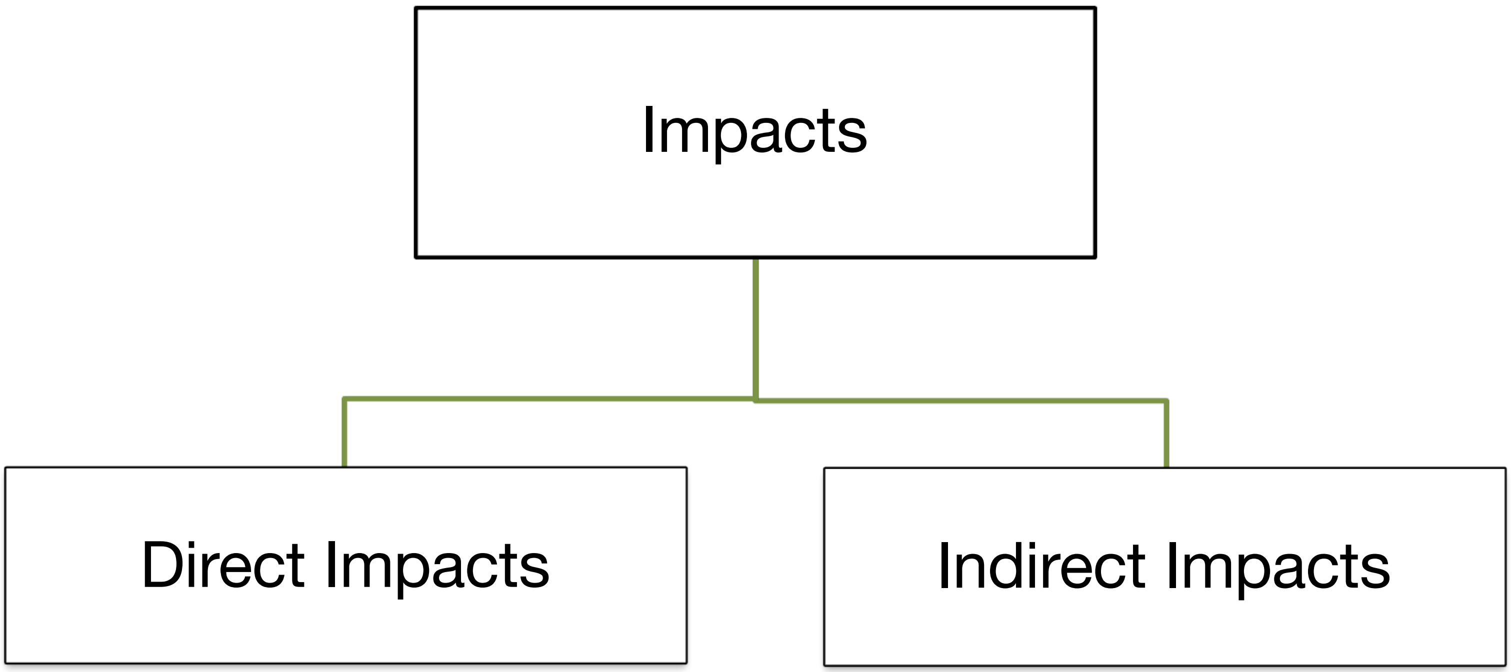
“The Contractor has a general duty to mitigate the effect on its works of Employer Risk Events. Subject to express contract wording or agreement to the contrary, the duty to mitigate does not extend to requiring the Contractor to add extra resources or to work outside its planned working hours”

The Society of Construction Law (SCL) Delay and Disruption Protocol

Impact of Construction Claims

- Cost
- Time
- Time & Cost

Types of Impact

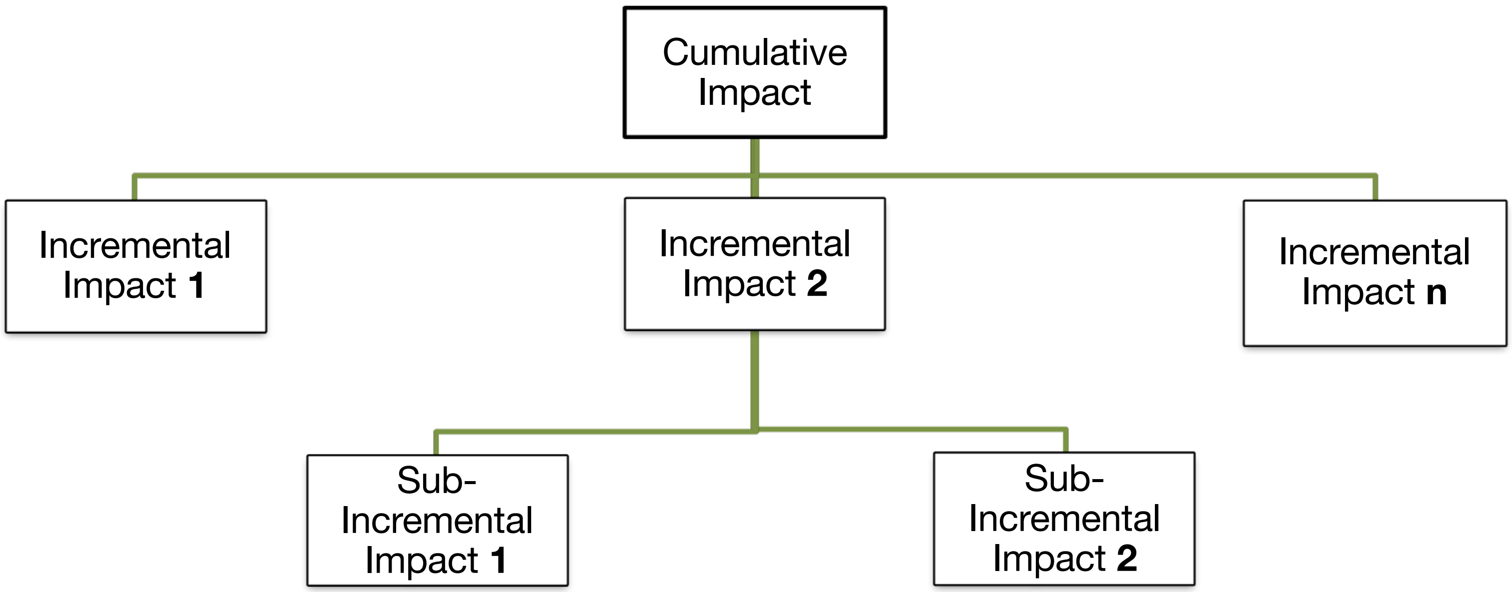


Types of Impact

- Direct Impacts: refers to the direct impact of changed work over ongoing original work

- Indirect Impacts: refers to the effect of changes on the work due to disruption: e.g., site congestion, disruption due to relocation, loss of learning curve, impact on worker motivation, rework, etc.

Incremental vs. Cumulative Impact



Incremental vs. Cumulative Impact

- Incremental Impact: multiple changes to a project that are taken and analysed individually to assess their effect on time & cost

- Cumulative Impact: multiple changes to a project that when taken individually do not have significant impact to the project, but when taken cumulatively, their impact is significant on time and cost

Incremental vs. Cumulative Impact

- The Construction Industry Institute (CII) has explained the notion of cumulative impact as follows: “When there are multiple changes on a project and they act in sequence or concurrently, there is a compounding effect – this is the most damaging consequence for a project and the most difficult to understand and manage. The net effect of the individual changes is much greater than the sum of the individual parts.”

Emelyn Warde Martinez (2010). Dealing with Cumulative Impact Claims.

Incremental vs. Cumulative Impact

- Cumulative impact delays usually come from several change orders, site instructions, RFI's, differing site conditions, suspensions of work, or other work disruptions that are widely recognized as compensable delays

- Additional work adds complexity, creates congestion on site, disrupts work, creates additional learning curves, and may lead to rework

Delay Analysis in Construction Projects

A delay is an **event** or **act** that prevents the execution of certain **task(s).** This prevention leads to an extended finish date of the project and associated prolongation costs, if any.

1. Opportunity for contractors to recover damages (as long as contracting has been in existence)

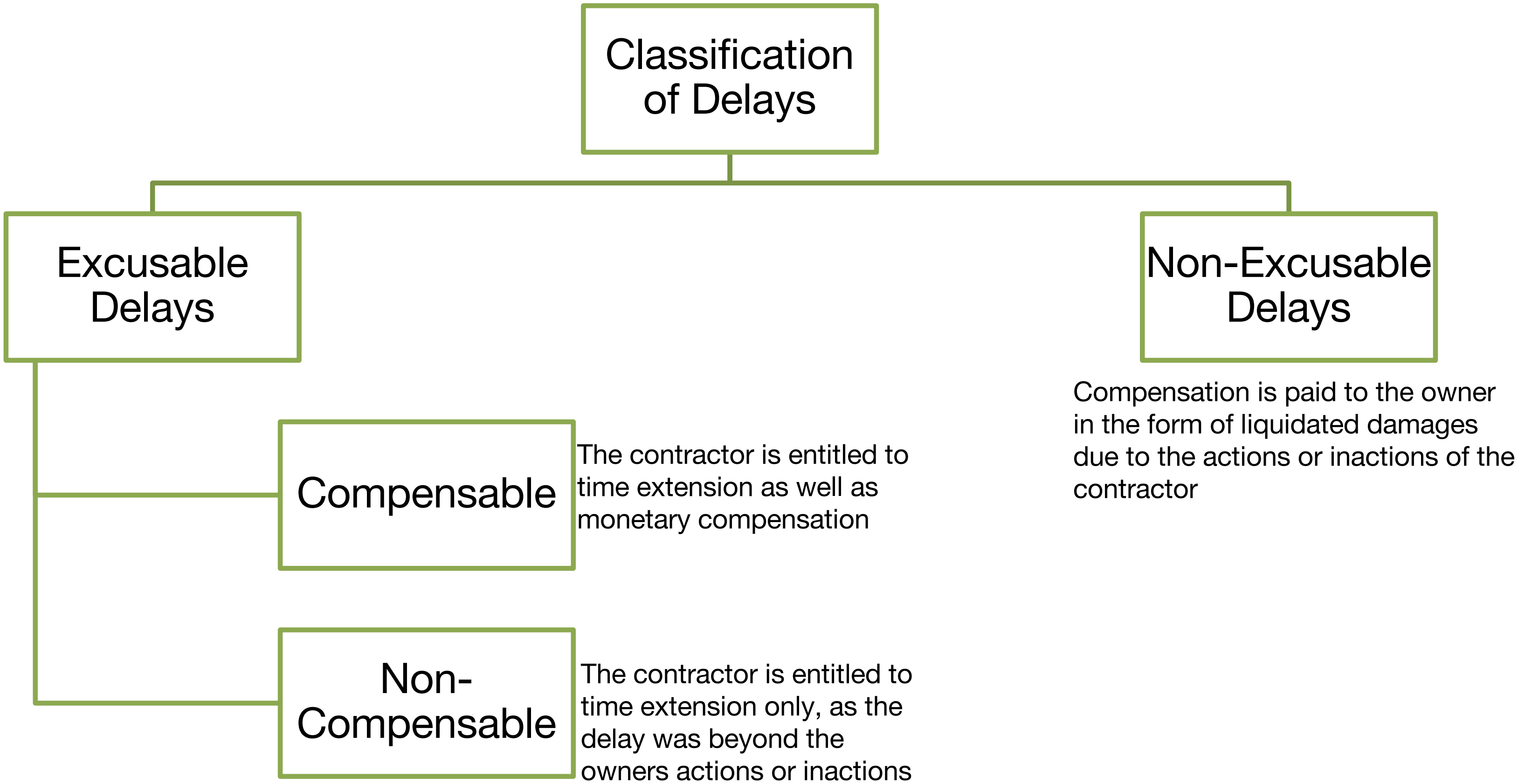
2. Evolved from simple bar charts (1914) to sophisticated software tools available today

Delay Analysis in Construction Projects

Categories of Delays

1.Independent Delay	2. Serial Delay	3.Concurrent Delay
Occur in isolation & do not result from a previous delay	Result from unrelated delay in a preceding task	More than 1 delay occurring in the same time, and if any of other delays had not occurred, the project would have still been delayed by the remaining delay(s)

Delay Analysis in Construction Projects



Delay Analysis in Construction Projects

- Concurrent Delays:

1- Two or more separate delays that occur in the same time period

2- Two or more separate delays that occur in the same time period but in two parallel critical paths

3- Two or more separate delays that occur in the same time; even if one had not occurred, the project would have been delayed by the **SAME** amount of time

4- Concurrent delays must fulfill the following requirements:

- Occur in the same time period
- Each of them has the ability to affect project duration

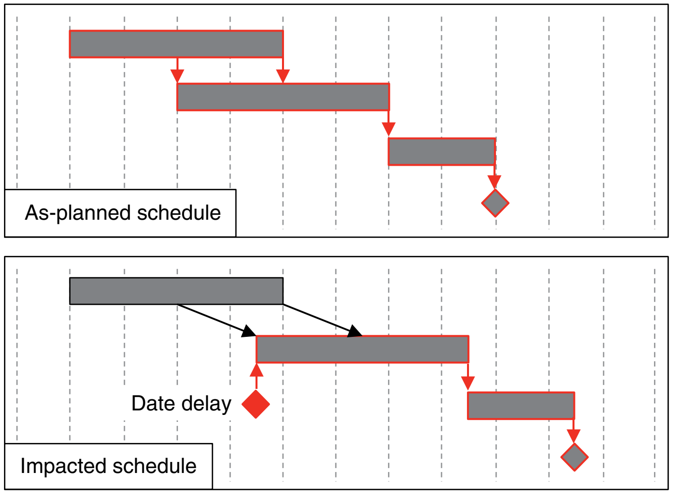
Delay Analysis in Construction Projects

- Concurrent Delays Impact

Delay Type	***Excusable compensable delay***	***Excusable non-compensable delay***	***Non-excusable delay***
Excusable compensable delay	**Extension of Time + Damages Compensation for the Contractor**	Extension of Time for the Contractor	Extension of Time for the Contractor
Excusable non-compensable delay	Extension of Time for the Contractor	Extension of Time for the Contractor	Extension of Time for the Contractor
Non-excusable delay	Extension of Time for the Contractor	Extension of Time for the Contractor	**Liquidated Damages for the Owner**

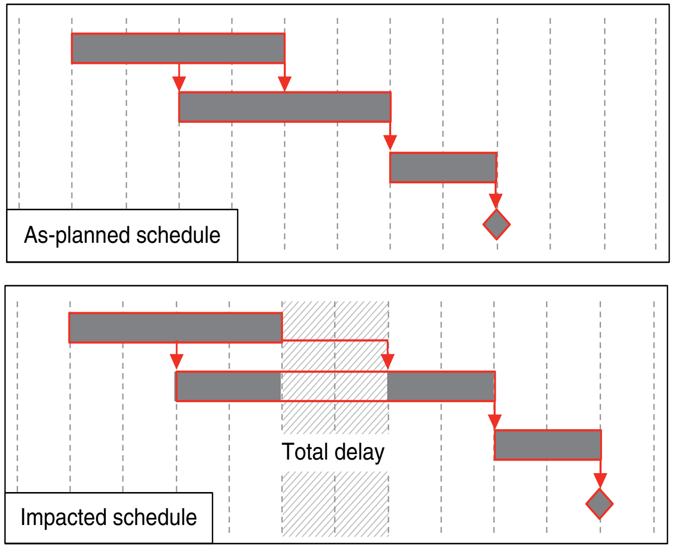
Delay Analysis in Construction Projects

- Types of Delay:
- Date Delay: is where an activity cannot start and/or finish until a specific date irrespective of when preceding activities were planned or were to be carried out
- It is modelled by the addition of a milestone with a constrained date
- Example: Delay in release of design



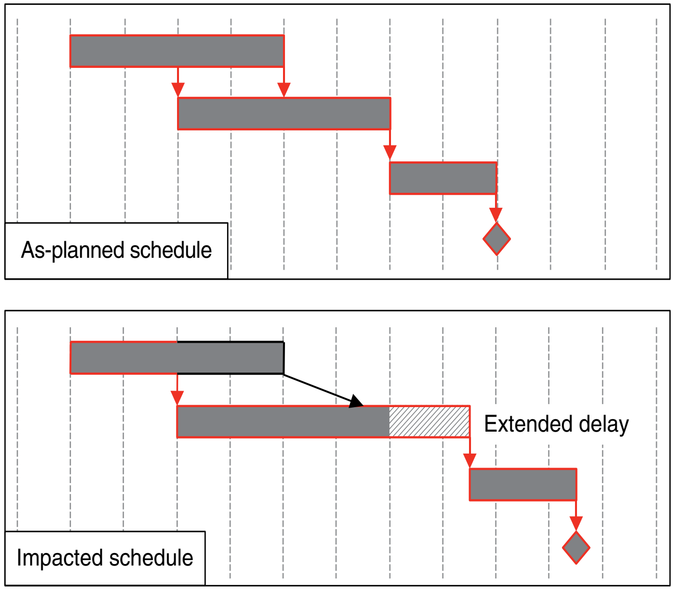
Delay Analysis in Construction Projects

- Total Delay: is where a complete stoppage of work is caused
- It is modelled by changing the calendar for the relevant activities
- Example: Strikes and lockouts



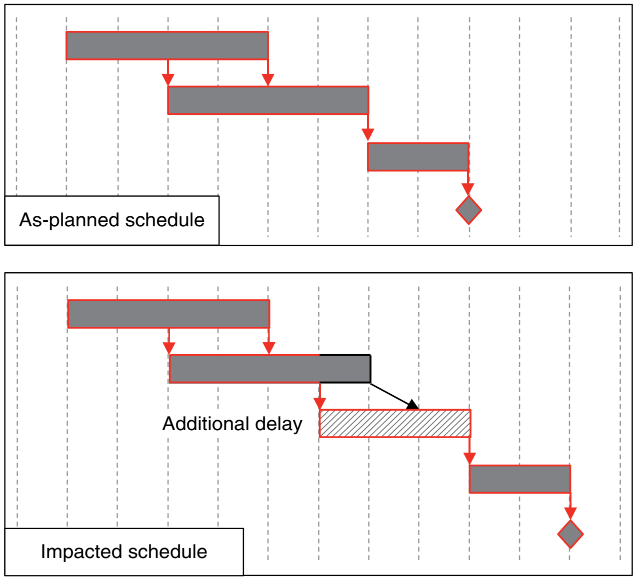
Delay Analysis in Construction Projects

- Extended Delay: is where the as-planned duration of an activity is increased
- It is modelled by increasing the duration of the relevant activities
- Example: Increase in quantity of activity



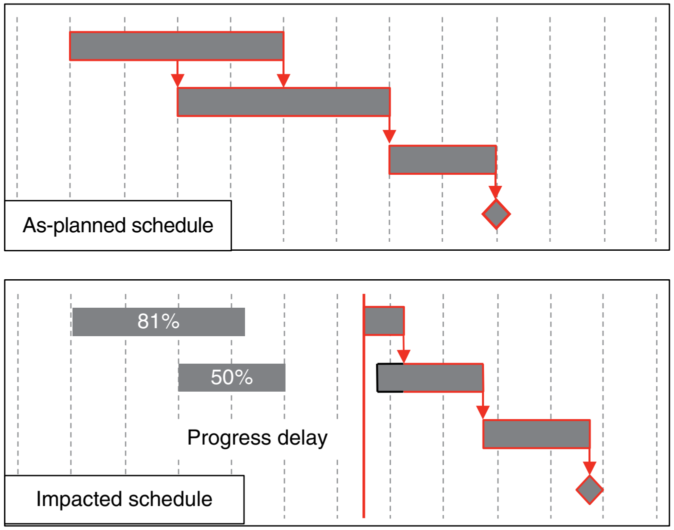
Delay Analysis in Construction Projects

- Additional Delay: is where there is a need to insert additional activities to the schedule.
- It is modelled by adding additional activities and linking them into the as-planned network
- Example: New or additional work requests



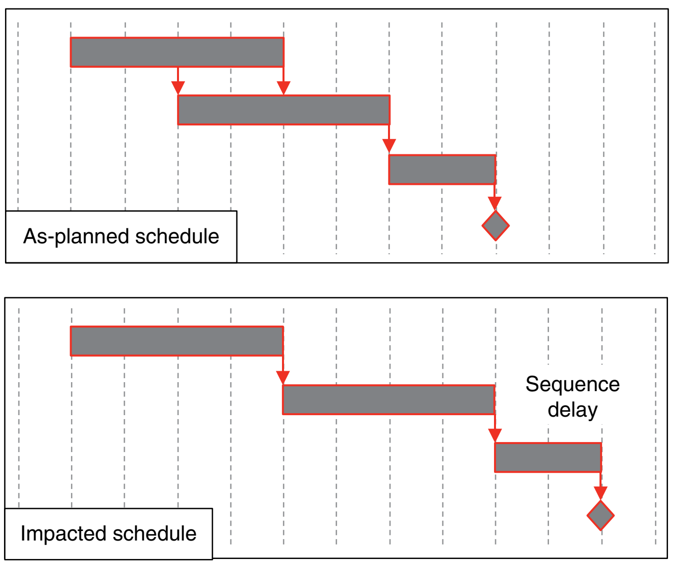
Delay Analysis in Construction Projects

- Progress Delay: is where the %complete of the activity as compared to the plan is showing a delay
- It is modelled by the introduction of progress to the network (function built into Scheduling software)
- Example: Poor site management



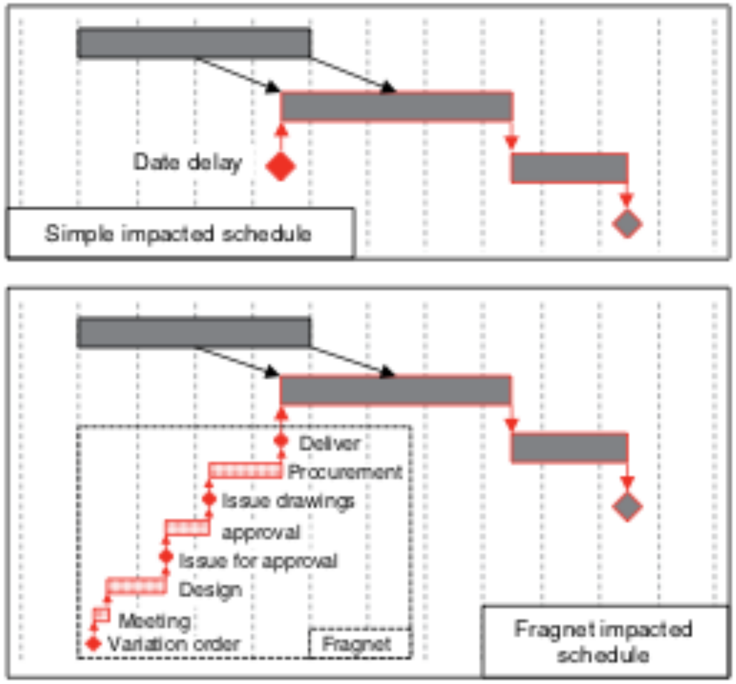
Delay Analysis in Construction Projects

- Sequence Delay: when a delaying event affects the planned sequence of activities envisaged on the as-planned schedule
- It is modelled by adjusting the logic of the schedule to take account of the revised sequence
- Example: Change in specification of materials



Delay Analysis in Construction Projects

- Modeling Delays
- Fragnets
- Usually delays are modeled by inserting simple single delay activities. For more complex cases, Fragnets are used to represent a complete delay schedule information



Delay Analysis in Construction Projects

- Modeling Delays
- As-Planned or Baseline Schedule
- Is integral to determining and modeling the effect of changes and relevant events
- This schedule is often developed in a relatively short period of time, without full information and working to deadlines for submission
- Is fundamental for preparing claims for disruption and extensions of time because it allows the planner to demonstrate the effects of events on the likely completion of the works
- However, if the schedule is not constructed correctly, whilst it may *appear* to reflect the preferred sequence and timing of the works in the static state, it will not realisti- cally forecast changes when current progress,

Delay Analysis in Construction Projects

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  - Is fundamental for preparing claims for disruption and extensions of time because it allows the planner to demonstrate the effects of events on the likely completion of the works
  - However, if the schedule is not constructed correctly, it will not realistically forecast changes when current progress, delays and such like are added to the schedule
  - Incorrectly developed schedule will provide misleading and inaccurate results

Delay Analysis in Construction Projects

- Modeling Delays
- Correcting As-Planned or Baseline Schedule
  - Not everything can be corrected, wherever possible, changes, corrections, additions, and the like should be made jointly

- Acceptable or Necessary Corrections
- Key contract dates
  - Project start and finish dates, key sectional completion dates
- Missing logic links
  - Every activity should have at least one predecessor start link and at least one successor finish link
  - Other wise, dangle activities will be present on the schedule

Delay Analysis in Construction Projects

- Missing logic links

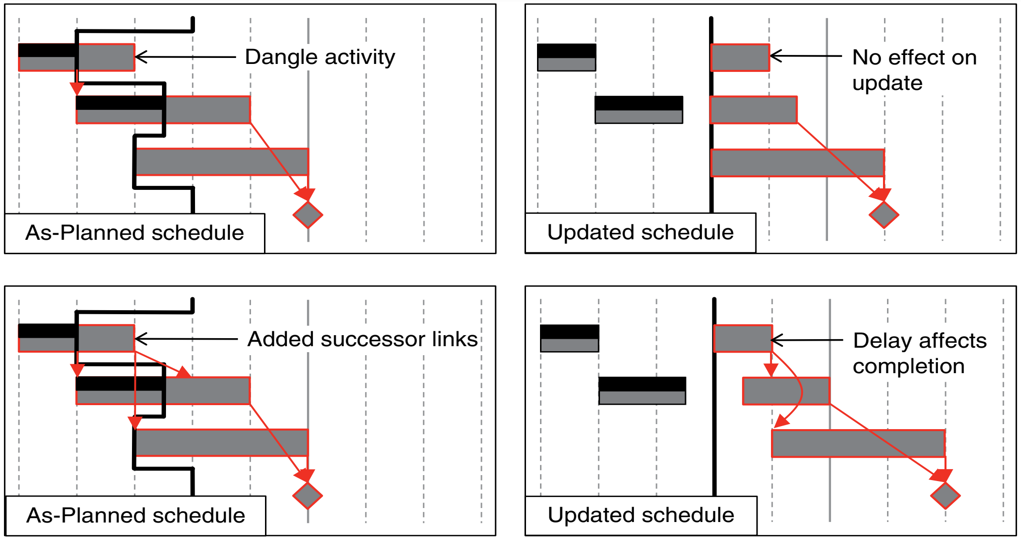


Figure 14.1 (a) Unlinked activity does not affect project completion. (b) Knock-on effect of dependency links.

- Constraints: Are dates added (e.g. Start On or Finish On) to an activity that can override their start or finish
- Activity durations: Especially for specialist works where duration estimates could inaccurate
- Sequence of activities: Such as swapping the order of activities
- Missing and Additional activities:
- Scope Changes:

Delay Analysis in Construction Projects

- According to the recommended Practice for Forensic Schedule Analysis (AACE International, 2011) for baseline (as-planned schedule) selection, validation and rectification says:
    1. *Ensure that the baseline schedule is the earliest, conformed plan for the project. If it is not the earliest, conformed plan, be prepared to identify the significant differences and the reasons why the earliest, conformed plan is not being used as the baseline schedule*.
    2. *Ensure that the work breakdown and the level of detail are sufficient for the intended analysis*.
    3. *Ensure that the data date is set at notice-to-proceed (or earlier) with no progress data for any schedule activity that occurred after the data date*.

Delay Analysis in Construction Projects

- As-planned schedule (selection, validation and rectification):
  4. *Ensure that there is at least one continuous critical path, using the longest path criterion that starts at the earliest occurring schedule activity in the network (start milestone) and ends at the latest occurring schedule activity in the network (finish milestone).*
  5. *Ensure that all activities have at least one predecessor, except for the start milestone, and one successor, except for the finish milestone.*
  6. *Ensure that the full scope of the project/contract is represented in the schedule.*
  7. *Investigate and document the basis of any milestones dates that violate the contract provisions.*

Delay Analysis in Construction Projects

- As-planned schedule (selection, validation and rectification):
  8. *Investigate and document the basis of any other aspect of the schedule that violates the contract provisions.*
  9. *Document and provide the basis for each change made to the baseline for purposes of rectification.*
  10. *Ensure that the calendars used for schedule calculations reflect actual working day constraints and restrictions actually existing at the time when the baseline schedule was prepared.*
  11. *Document and explain the software settings used for the baseline schedule.*

Delay Analysis in Construction Projects

- Modeling Delays
- As-Built/Progress Reports
- Record Keeping:
  - Minimum progress data: actual start and finish date of each activity and the progress of the activity at the end of each week.
  - The best way for this to be achieved is for the staff on the project to keep detailed daily site diaries.
- The records shall be in a form as agreed between the parties and shall include (SCL, 2002):
  - *2.2.1 identification of contractor/subcontractor working and their area of responsibility;*
  - *2.2.2 operating plant/equipment with hours worked, idle or down for repair;*
  - *2.2.3 work performed to date giving the location, description and by whom, and reference to the contract schedule;*

Delay Analysis in Construction Projects

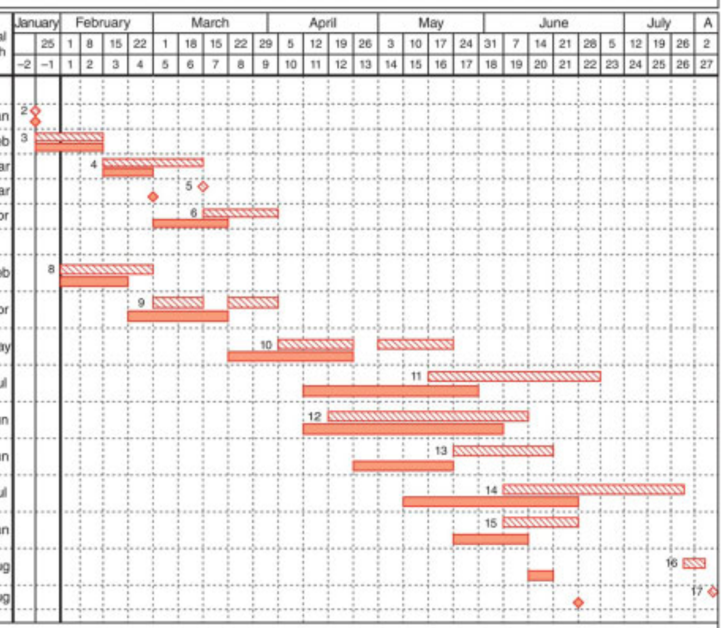
- *2.2.4 test results and references to specification requirements. Lists deficiencies identified, together with the corrective action;*
- *2.2.5 material received with statement as to its acceptability and storage;*
- *2.2.6 information or drawings reviewed with reference to the contract specification, by whom, and actions taken;*
- *2.2.7 job safety evaluations;*
- *2.2.8 progress photographs;*
- *2.2.9 a list of instructions given and received and any conflicts in plans and/or specifications;*
- *2.2.10 weather conditions encountered;*
- *2.2.11 the number of persons working on-site by trade, activity and location;*
- *2.2.12 information required from and by the Employer/ER;*
- *2.2.13 any delays encountered.*

Delay Analysis in Construction Projects

- Modeling Delays
- As-Built Schedule
- Illustrates what did happen on the project as opposed to what was planned to happen.

As-built schedule

Line	Name	Planned start	Planned duration	Planned Finish	Actual start	Actual Duration	Actual Finish
1	**Steelwork design & procurement**						
2	Finalised data from RE	25 Jan	0w	25 Jan	25 Jan	0d	25 Jan
3	Steelwork design	25 Jan	3w	12 Feb	25 Jan	3w	12 Feb
4	Design approval period	15 Feb	2w	26 Feb	15 Feb	4w	12 Mar
5	Design approval	26 Feb	0w	26 Feb	12 Mar	0d	12 Mar
6	Manufacture & delivery	01 Mar	3w	19 Mar	15 Mar	3w	02 Apr
7	**Site works**						
8	Clear site and RL excavation	01 Feb	3w	19 Feb	01 Feb	4w	26 Feb
9	Exc & FRC bases	22 Feb	4w	19 Mar	01 Mar	4w	02 Apr
10	Steelwork erection	22 Mar	5w	23 Apr	05 Apr	6w	21 May
11	Roof cladding & rooflights	12 Apr	7w	28 May	17 May	7w	02 Jul
12	Wall cladding & loading doors	12 Apr	8w	04 Jun	19 Apr	8w	11 Jun
13	Fill & FRC ground slab	26 Apr	4w	21 May	24 May	4w	18 Jun
14	Services installations	10 May	7w	25 Jun	07 Jun	7w 2d	27 Jul
15	Racking	24 May	3w	11 Jun	07 Jun	3w	25 Jun
16	Signange, fittings & fixtures	14 Jun	1w	18 Jun	28 Jul	1w	03 Aug
17	Handover key date 1	25 Jun	0w	25 Jun	03 Aug	0d	03 Aug



Legend

As-built (Actual)

Baselines

As-planned baseline

Delay Analysis in Construction Projects

- Methods of Delay Analysis
- Common Techniques include:
  - Global Impact Method
  - As-Planned Method
  - Modified As-Built Method
  - Net Impact Method
  - As-Built Method
  - But-for “Collapsing” Technique
  - Snapshots “Windows” Technique
  - Time Impact Analysis Technique
  - Delay Section Method
  - Isolated Delay Type Method
  - Float Allocation Method (U.S Board of Contracts Appeal)
  - Concurrent Delay Method

Delay Analysis in Construction Projects

- Methods of Delay Analysis: Two publications, considered to be more balance and independent view of the subject of delay and disruption and how the analysis may be approached, are:
  - **The Society of Construction Law Delay and Disruption Protocol:**
  - Includes guidelines for core principles, preparing and maintaining schedules and records, dealing with EOT during construction, and disputed EOT issues after completion

Table 15.1 Methods of analysis and the required factual material 1.

Type of analysis	As-planned schedule without network	Networked as-planned schedule	Updated as-planned networked schedule	As-built records
As-planned versus as-built	**X**	or **X**	and **X**	or **X**
Impacted as-planned		**X**		
Collapsed as-built				**X**
Time impact analysis		**X**	or **X**	and **X**

Adapted from SCL Protocol table 4.13.

- **Advancement of Cost Engineering International (AACEI) recommended practice 29R-03 – Forensic schedule analysis**
- Includes five sections addressing organization and scope, source validation, method implementation, analysis evaluation, and choosing a method together with appendices.

Table 15.2 AACEI RP taxonomy and nomenclature hierarchy.

Layer 1	Layer 2	Layer 3	Layer 4		Layer 5
Timing	**Basic methods**	**Specific methods**	**Basic implementation**		**Specific implementation**
Retrospective	Observational	Static logic	3.1	Gross	
			3.2	Periodic	Fixed periods
					Variable periods or grouped
		Dynamic logic	3.3	Contemporaneous as-is	All fixed periods
					Variable periods or grouped
			3.4	Contemporaneous split	All fixed periods
					Variable periods or grouped
			3.5	Modified / recreated updates	All fixed periods
					Variable periods or grouped
	Modelled	Additive modelling	3.6	Single base model	Global insertion
					Stepped insertion
			3.7	Multiple base model	Fixed periods
					Variable periods or grouped
		Subtractive modelling	3.8	Single simulation model	Global extract
					Stepped extract
			3.9	Multiple simulation models	Periodic modelling
					Cumulative modelling

Table 15.3 Common names for methods of analysis.

Taxonomic description	Common name
3.1 Observational : Static logic : Gross	As-planned vs. as-built AP vs. AB Planned vs. actual As-planned vs. update
3.2 Observational : Static logic : Periodic	As-planned vs. as-built AP vs. AB Planned vs. actual As-planned vs. update Window analysis Windows analysis
3.3 Observational : Dynamic logic : Contemporaneous updates : All Periods	Contemporaneous period analysis Contemporaneous project analysis Observational CPA Update analysis Month-to-month Window analysis Windows analysis
3.4 Observational : Dynamic logic : Contemporaneous updates : Grouped periods	Contemporaneous period analysis Contemporaneous project analysis Contemporaneous schedule analysis Bifurcated CPA Half-stepped update analysis Two-stepped update analysis Month-to-month Window analysis Windows analysis
3.5 Observational : Dynamic logic : Modified/recreated updates	Update analysis Reconstructed update analysis Month-to-month Window analysis Windows analysis
3.6 Modelled : Additive : Single base	Impacted as-planned (IAP) Impacted baseline (IB) Plan plus delay Impacted update analysis Time impact analysis (TIA) Time impact evaluation (TIE) Fragnet insertion Fragnet analysis
3.7 Modelled : Additive : Multi base	Window analysis Windows analysis Impacted update analysis Time impact analysis (TIA) Time impact evaluation (TIE) Fragnet insertion Fragnet analysis

Table 15.3 (*Continued*)

Taxonomic description	Common name
3.8 Modelled : Subtractive : Single simulation	Collapsed as-built (CAB) But-for analysis As-built less delay Modified as-built
3.9 Modelled : Subtractive : Multi simulation	Collapsed as-built (CAB) Windows collapsed as-built But-for analysis Windows as-built but-for As-built less delay Modified as-built Look-back window

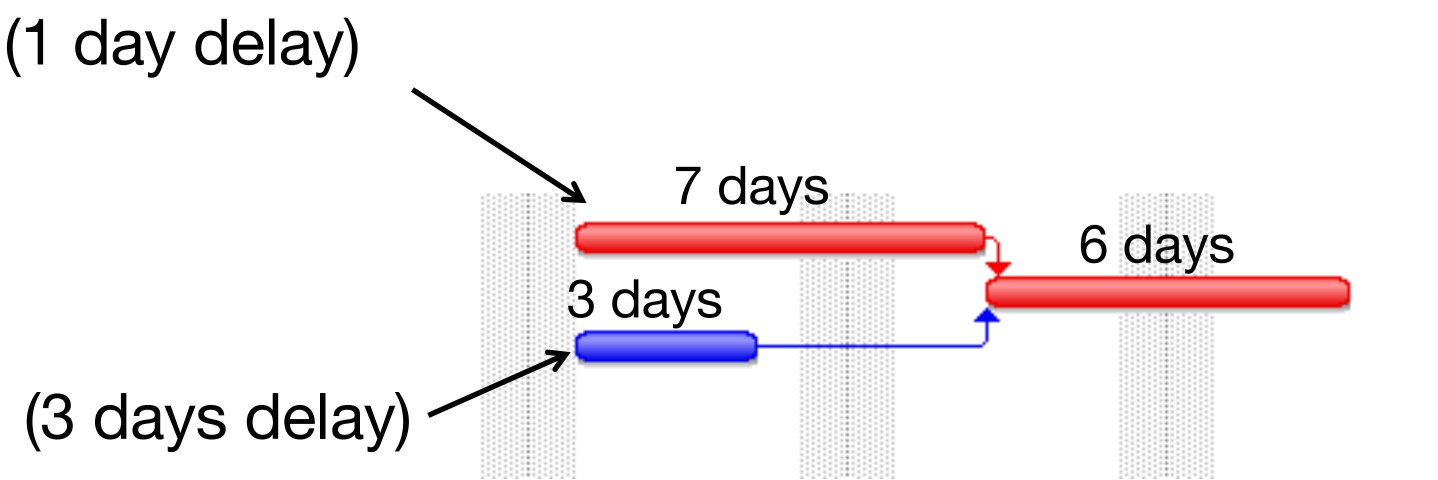
Table 15.4 Methods of analysis and the required factual material 2.

Source schedules or data	Method								
	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
Baseline schedule	X	X				X	X		
Schedule updates			X	X			X		X
As-built records	X	X			X			X	X

Adapted from AACEI RP figure 18.

Delay Analysis in Construction Projects

- Global Impact Method



Total Delay (According to GIM) = 4 days

Actual Delay = 1 day (since the 3 days delay did not affect the critical path)

Delay Analysis in Construction Projects

- Global Impact Method

Advantages:

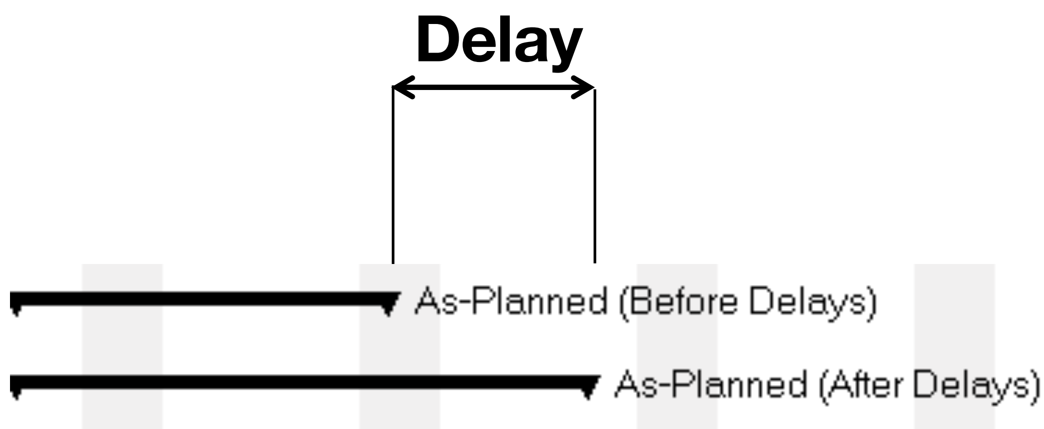
- Easy to use
- No CPM required

Disadvantages:

- Concurrency is neglected in this technique
- Types of delays are neglected
- Assumes all delays affect project completion

Delay Analysis in Construction Projects

- As-Planned Method



Note: The contractor will not be entitled to time compensation if the delays incorporated do not have an effect on the project completion date

Delay Analysis in Construction Projects

- As-Planned Method

Advantages:

- Comparison done relative to the as-planned schedule

Disadvantages:

- Does not identify types or responsibility of delays
- Assumes static critical path

Delay Analysis in Construction Projects

- Modified As-Built Method

- Delays are incorporated as activities & linked
- Critical path(s) are identified twice (planned & at end of project on the as-built schedule)
- The difference in finish dates is the amount of extension claimed

Delay Analysis in Construction Projects

- Modified As-Built Method

Advantages:

- CPM to illustrate changes
- Logic is identified

Disadvantages:

- Does not deal with types and responsibility of delays

Prolongation Cost Calculation and Assessment

- Determine damages for all changes
- Determine delay damages and/or acceleration cost
- Determine damages due to productivity loss
- Determine extended overheads and/or liquidated damages
- Determine claim preparation cost

Prolongation Cost Calculation and Assessment

- Calculate loss of interest on capital, if any
- Check calculations of damages with established methods and/or practice
- Summarize damages
- Create report

M.A Baki (1999). Delay Claims Management in Construction - A step-By-Step Approach.

Prolongation Cost Components

1. Additional supervisory personnel costs
2. Increased material costs
3. Increased labour costs
4. Increased equipment costs
5. Extended head office overheads
6. Additional site overheads
7. Borrowing costs (escalation costs)
8. Interest costs (rise and fall costs)
9. Claim preparation cost
10. Disruption cost (loss of productivity & efficiency)

Prolongation Cost

- Concurrent Delays:

"If the Contractor incurs additional costs that are caused both by an Employer Delay and concurrent Contractor Delay, then the Contractor should only recover compensation to the extent it is able to separately identify the additional costs caused by Employer Delay from those caused by the Contractor Delay"

The Society of Construction Law (SCL) Delay and Disruption Protocol

Methods for Quantifying Delay Cost

- Total cost method: involves a simple claim calculation based upon the assumption that all cost overruns are the result of the owner's actions

- Modified total cost method: involves calculating the contractor's cost overrun due to owner's actions and subtracting any costs associated with the contractor's bid error or performance problems

Methods for Quantifying Delay Cost

- Jury Verdict Method: If there is no way that a contractor can calculate its damages with any certainty, it leaves the calculation to the hands of the court by way of the jury verdict method. This methodology is typically employed when there is clear proof that the contractor was injured, but there is no reliable method of determining damages

Methods for Quantifying Delay Cost

- Measured Mile Method: compares identical activities in the impacted and non-impacted sections of the project in order to ascertain the loss of productivity resulting from the impact of the known set of events

- The Measured Mile calculation is favoured because it considers only the actual effect of the alleged impact and thereby eliminates disputes over the validity of cost estimates

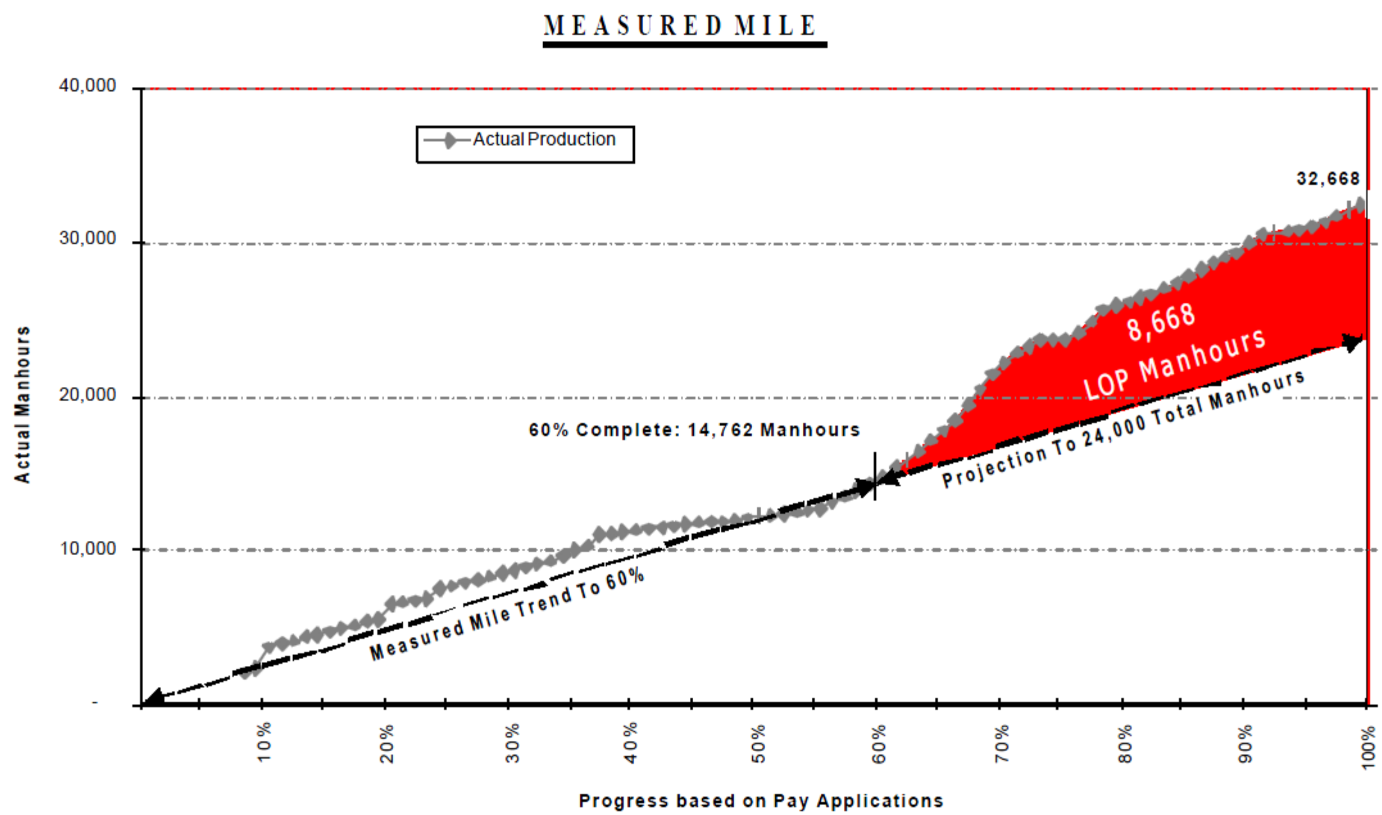
Methods for Quantifying Delay Cost

- A "measured mile" analysis compares the productivity of a period that has been impacted by negative conditions to the productivity of similar work under normal conditions (for identical activities)

- The difference between the actual (inefficient) productivity and an identified normal productivity is the amount of excess cost and time to the contractor as a direct result of loss of productivity

Emelyn Warde Martinez (2010). Dealing with Cumulative Impact Claims.

Measured Mile Analysis



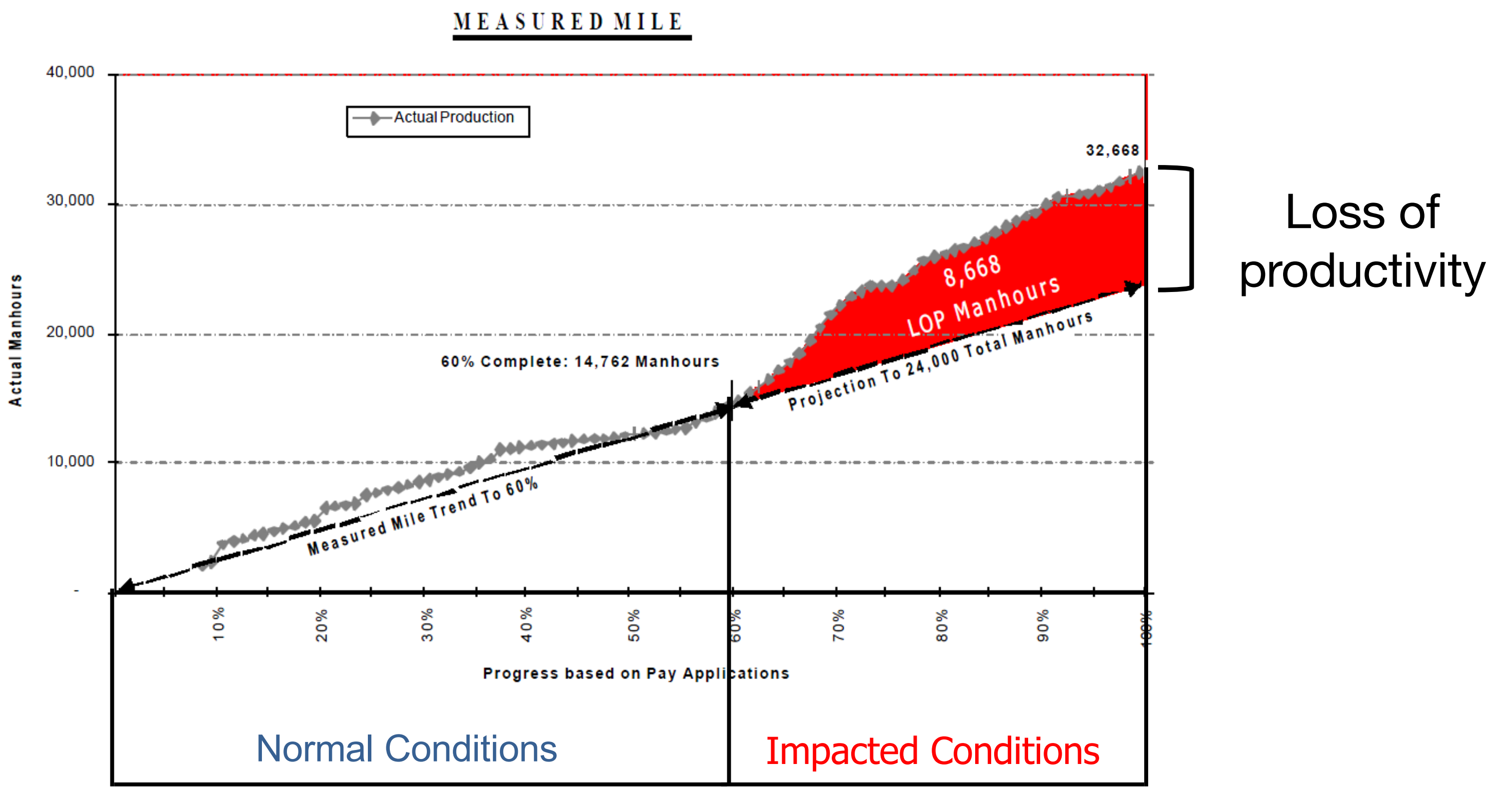
LOP = Loss of productivity

Timothy T. Calvey, and William R. Zollinger III (2003). Measured Mile Labor Analysis.

Measured Mile Analysis

- Actual productivity under normal conditions was measured up to 60% of project
- Productivity for normal conditions was projected for the remaining percentage of work
- Projected productivity was measured against actual productivity under impacted conditions for remaining percentage of project
- The difference is the LOP as a result of disruption that occurred

Measured Mile Analysis



Cost Impact Labour = [*X* Impacted Conditions (hrs) - *X* Normal Conditions (hrs)] * Average hourly cost

Measured Mile Analysis

Example:

Given the previous case:

1 crew = 8 mhrs/hr

@ $168.25/hr (for the crew)

What is the cost impact for the disruption of work?

Cost Impact Labour=[32,668 mhrs/8 mhrs/hr – 24,000 mhrs /8 mhrs/hr] * $168.25/hr

Cost Impact Labour= $182,298.88

Time & Cost Entitlement

"Entitlement to an EOT[1] does not automatically lead to entitlement to compensation (and vice versa)"

(1) Extension of Time (EOT)

The Society of Construction Law (SCL) Delay and Disruption Protocol

Time & Cost Entitlement

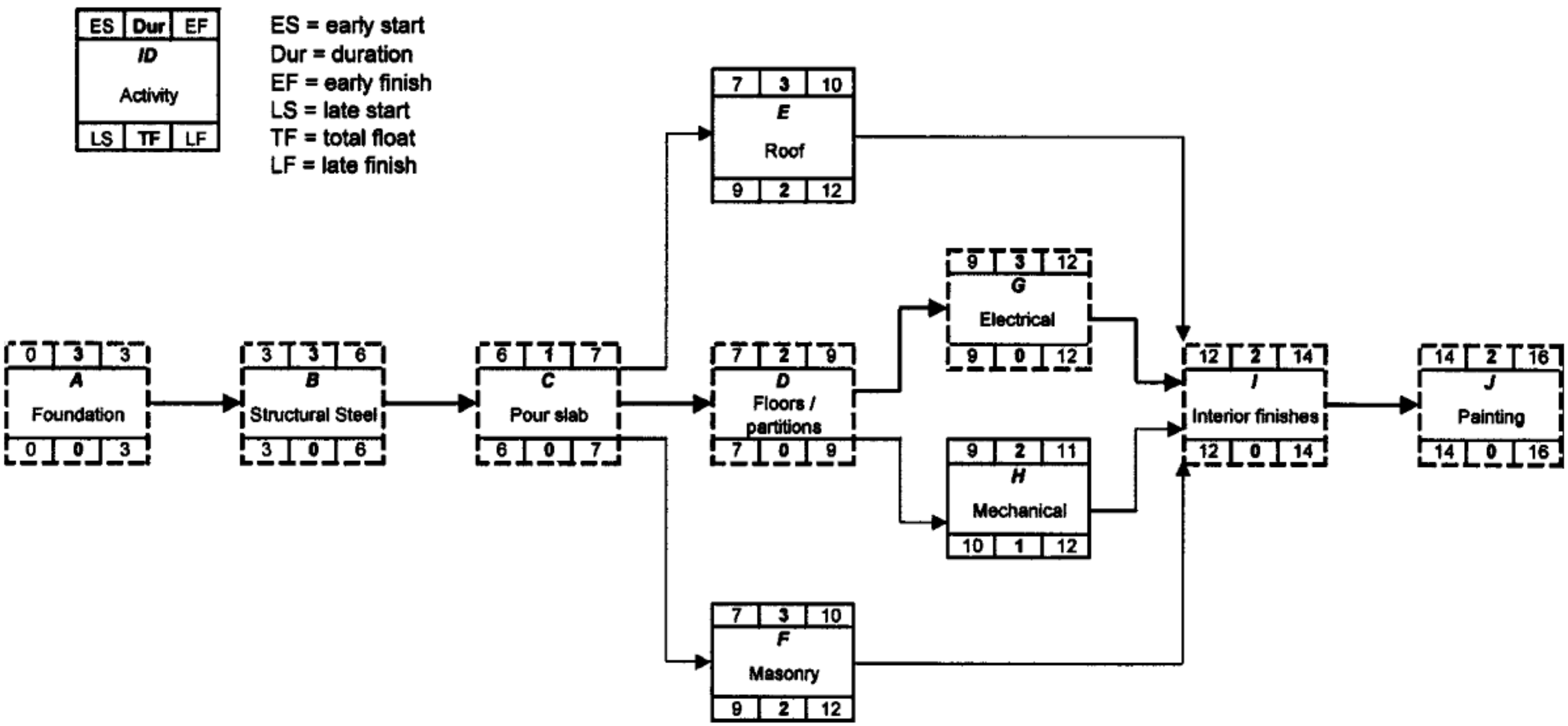
- Once Time & Cost entitlement have been defined, two possible scenarios might arise:

1. Claim processed and enters negotiation process for final approval

2. Claim rejected (Time at Large)

Example

- For a hypothetical commercial building, the following network diagram illustrates the sequence of construction:



Example

- The following delays were encountered prior to the slab pouring task:

- The designer increased the thickness of the slab; this increase will require 1 additional week as the slab will be cast in two layers and not just one as planned; this information was released just before commencing work on the activity and requires additional Engineering works

- The contractor’s concrete pump had a breakdown – prior to starting the slab activity - and required 2 weeks for repair

Example

- Assuming foundation and steel works were completed on time:

- Assuming remaining activities progressed as planned, calculate the amount of delay the project encountered

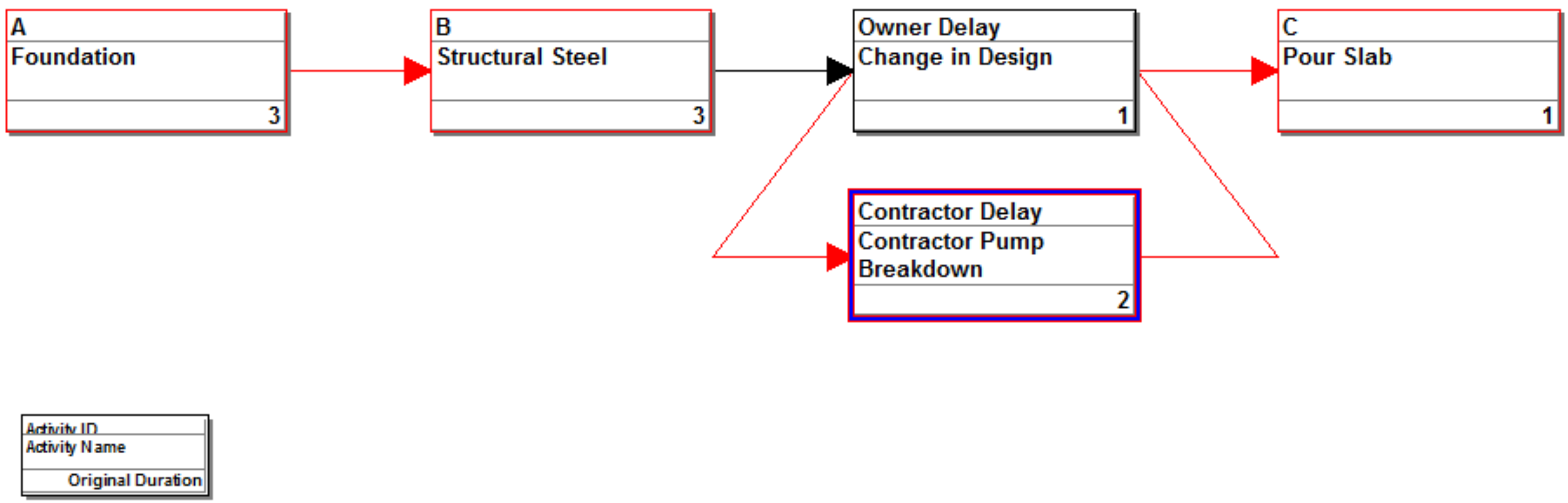
- Define the two type of delays encountered and whether they are concurrent or not

Example

- Assuming the daily additional cost (direct + indirect) for the project is X, and the amount of liquidated damages to be paid for every additional week after contractual project completion is Y, given X<Y.
- What is the additional cost incurred due to the 2 delays, assuming that the contactor has decided not to accelerate the schedule to meet the contractual completion date?

Example

- The amount of delay the project encountered is **2 weeks**



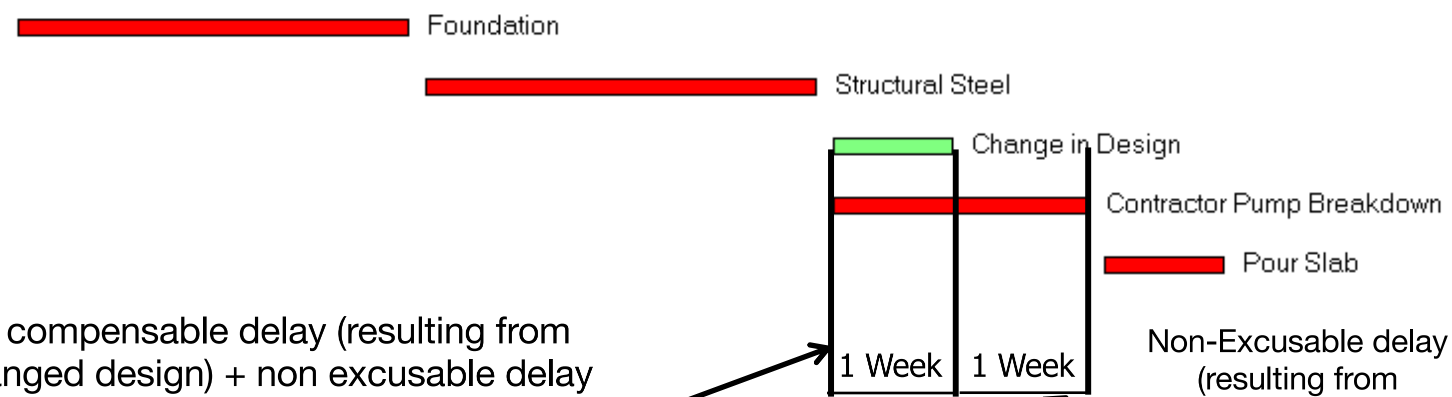
Example

- Define the two type of delays encountered and whether they are concurrent or not:

Owner Delay Event = 1 week

Contractor Delay Event = 2 week

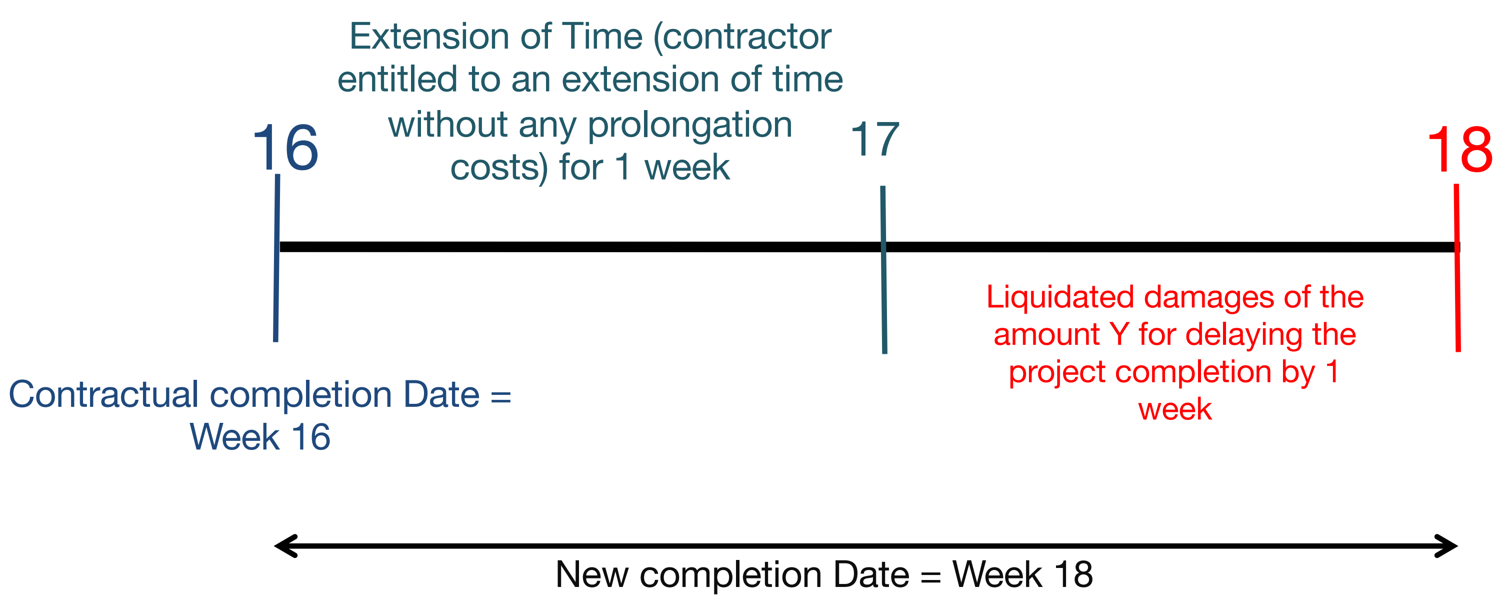
Concurrent Delays with a degree of overlap



Excusable compensable delay (resulting from owner's changed design) + non excusable delay (resulting from contractor's pump breakdown) = Extension of Time (contractor entitled to an extension of time without any prolongation costs)

Non-Excusable delay (resulting from contractor's pump breakdown) resulting in liquidated damages

Example


Extension of Time (contractor entitled to an extension of time without any prolongation costs) for 1 week
16
17
18
Liquidated damages of the amount Y for delaying the project completion by 1 week
Contractual completion Date = Week 16
New completion Date = Week 18

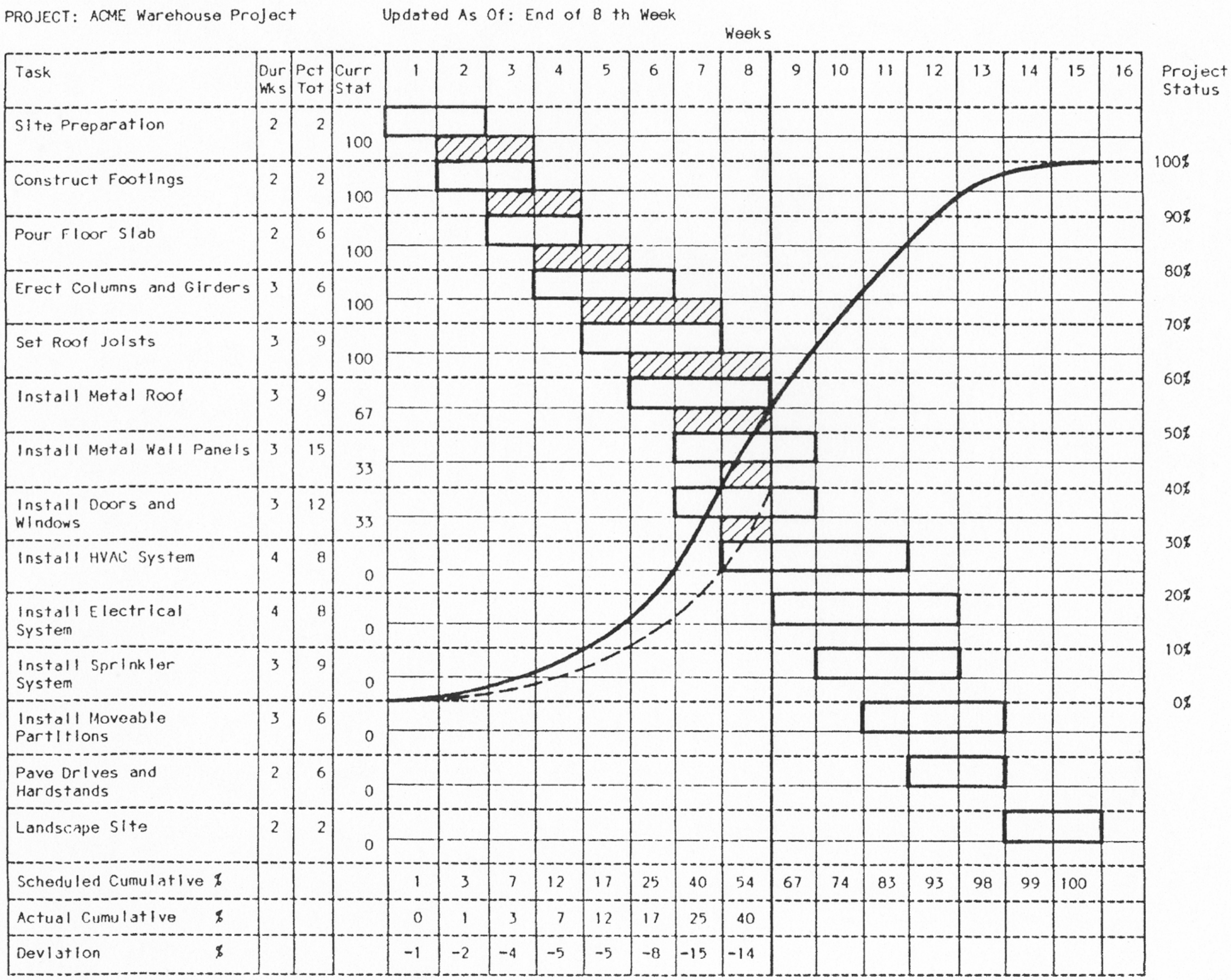
Example

- Conclusion:
- The contractor is required to pay liquidated damages in the amount of Y for the 1 additional week (non-excusable delay) of delay due to the pump breakdown.
- The new project completion date is 18 weeks from the commencement date of the project.

Example: Types of Changes

- Turnover of personnel
- Lack of funding to complete work (Owner)
- Communication breakdown within organizations
- Lack of skill and experience level to execute work
- Lack of quality of engineering
- Late delivery of engineering design and materials
- Compounding impact of numerous small changes

FIGURE 12.3
UPDATED BAR CHART FOR WAREHOUSE PROJECT



References:

- *CIV E 601: Project Management, Lecture Notes,* Fayek, A. R. University of Alberta, 2013.
- Baldwin, A. and Bordoli, D. (2014). *A Handbook for Construction Planning and Scheduling*, John Wiley and Sons.
- Society of Construction Law (SCL) (2002). SCL ‘model records clause’ (SCL, 2002, pp. 71–72).