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Study of Time Delays in Bridge Construction with Specific Context to Delay in Design Approval & Design Changes

Patel Hetal*, Maniya Tushar**
* Civil (Construction Project Management), Parul Institute of Technology
** Civil Department, Shree Dhanvantary Collage of Diploma Engineering, Kim-Surat

***Abstract*- Infrastructure projects are major drivers of economic growth of India. The industry's growth is deterred by poor project management practices leading to time delays, resource shortages and cost overruns. Delay reasons in infrastructure projects; their classification and their types are important to find out their implications. The delays occurring in a project can be classified into number of types depending upon the stages at which it occurs as well as on the nature of outcome. This defines the criticality of the delay in the overall project completion and its impact thereafter.**

Index Terms- Delays In Bridge Construction, Design Approval, Design Changes & Time Delay in Bridge Construction

I. INTRODUCTION

Construction delays are delays in progress compared to the baseline construction schedule. Delays occur commonly in construction projects. Such delays in construction can cause number of changes in a project such as late completion, lost productivity, acceleration, increased costs, and contract termination. The party experiencing damages from delay needs to be able to recognise the delays and the parties responsible for them in order to recover time and cost. However, in general, delay situations are complex in nature. A delay in an activity may not result in the same amount of project delay. A delay caused by a party may or may not affect the project completion date and may or may not cause damage to another party.

A delay can be caused by more than one party; however, it can also be caused by none of the parties or act of God (such as unusually severe weather conditions). A delay may occur concurrently with other delays and all of them may impact the project completion date. A delay may sometimes contribute to the formation of other delays. The delay occurring in a project can be classified into number of types depending upon the stages at which it occurs as well as on the nature of outcome like claims, impact on time schedule etc. This defines the criticality of the delay in the overall project completion and its impact thereafter.

The recourse is generally asking for compensation for the delay by the affected party from the other party and thus it is the choice of the affected party. In certain cases the affected party may excuse (i.e., he may not levy compensation for the delay) while in some other cases he may not excuse the delay. The consideration to excuse or not to excuse would depend on several factors such as whether a party can or cannot foresee the situation causing delay at the time of entering the contract; and the impact of delay on project performance. This leads to classify delays as 'excusable' or 'non-excusable'. However on certain situations when both parties are equally or partially responsible for the delay, the delay is called as 'concurrent' and analysis of actual damage due to delay with respect to levels of obligations stated in the contract and that actually performed helps in apportioning the quantum of losses to be shared by parties.

However, in more complex projects, problems will arise that are not foreseen in the original contract, and so other legal construction forms are subsequently used, such as change orders, lien waivers, and addenda. In construction projects, as well in other projects where a schedule is being used to plan work, delays happen all the time. It's what is being delayed that determines if a project, or some other deadline such as a milestone, will be completed late.

II. AIMS OF STUDY:

- Aim of the study is destroy delay problems as well as possible otherwise avoid the delay problems.
- we can complete project on time and under cost.

III. OBJECTIVES OF THE STUDY

The main objectives of this study include the following:

1. To identify the causes of delays in construction of bridges.
2. To study the delays in bridge construction due to design submission & design approval and its implications on the project.
3. To study the delays in bridge construction due to design changes in bridges and its implications on the project.

IV. LITERATURE REVIEW

Infrastructure is a major driver for India's economic growth. India's infrastructure industry presents a dichotomy to potential investors, on the one hand it has some of the biggest potential for growth and opportunities for investment in the world, and on the other hand, it suffers from a poor regulatory environment due time and cost overruns.

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- India Infrastructure Report, Q1 2011 including 5 year industry forecasts up to 2015 by BMI, December 2010, Published by Business Monitor International Ltd.

According to Midterm appraisal report of 11th Five Year Plan, the increase in investment in physical infrastructure from the level of about 5 per cent of GDP witnessed during the Tenth Plan to about 7.55 per cent of GDP by 2011-12.The Planning Commission has projected that investment in infrastructure would almost double at US$ 1025 billion in the 12th Plan, compared to US$ 514 billion in the 11th Plan. Of the US$ 1,025 billion, 50 per cent is expected to come from private sector, whose investment has been 36 per cent in the 11th Plan.

- India Infrastructure Statistics 2010, First Issue, Central Statistic Office, Ministry of Statistics and Programme Implementation Infrastructure and Project Monitoring Division, GOI, New Delhi, December 2010

Currently the infrastructure sector accounts for around 26.7 per cent of India's industrial output. The country's core sector, comprising six key infrastructure industries, accelerated by 7 per cent in October 2010 from a year ago, according to the data released by the Union Ministry of Commerce and Industry. According to forecasts by BMI, the construction industry will grow at the rate of 7.7% for the financial year 2010-2011; But data released by the central statistical organisation on Monday, 7th Feb, 2011 shows that GDP growth in construction sector in India have grew at the rate of 8.0 % in 2010-2011 as against 7.0% in 2009-2010.While infrastructure is driving the economic growth in India, the time and cost overruns impede the sector's potential. The industry's growth is deterred by poor project management practices leading to time delays, resource shortages andcost overruns.

- Project Implementation Status Report of Central Sector Projects Costing Rs.20 Cr. & Above, April-June, 2009, by Ministry of Statistics and Programme Implementation, Infrastructure and Project Monitoring Division, GOI, New Delhi

As per Project Implementation Status Report of Central Sector Projects Costing Rs.20 Cr. & above (April-June, 2009), out of 951 projects under consideration, 474 projects showing time overrun with respect to original schedule (Range 1 – 192 months) and the Percentage of cost overrun in 474 delayed projects is about 13.55%. This report further states that, upto March 2009; about 49.84% projects are running behind the schedule.

- Mid-Term Review of Eleventh Five Year Plan, Chapter 14, Planning Commission, Government of India, New Delhi, P.P. 298-310

The Annual report to the people on infrastructure 2009-10, by Planning Commission, Govt. of India states that some of the major reasons for delay in road project as, delay in pre-construction activities (including preparation of design and approval), local law & order problem, poor performance by some contractors etc. because of which the targets could not be met.

- KPMG-PMI Study on "Drivers for Success in Infrastructure Projects 2010", Conference on Project Management in Infrastructure Sector, March 2010, KPMG-PMI, India

A study on 'Key Drivers for Success in Infrastructure Projects in India' conducted by KPMG-PMI shows following alarming findings.

Government also agreed that about half of 961 projects were delayed due to cost overrun of over Rs. 40,000 Cr. (From Graph 2.1). 41% of the 1053 completed projects over the last 17 years (April 1992-March 2009) witnessed budget over runs while 82% of them witnessed schedule over runs (From Graph 2.2). The study has identified factors like inadequate design, planning and conceptualization, along with scope-creep and material cost escalations as the major reasons for cost overruns, while regulatory hurdles and land acquisition have been identified as the primary reasons for schedule overruns with landowners having the largest influence on this.83 percent of the respondents said frequent design change results in these cost overruns and about 75 percent cited that delays in regulatory approvals and land acquisition for project delays.Cost effective Project Designs emerged as one of the most efficient tool to control project costs

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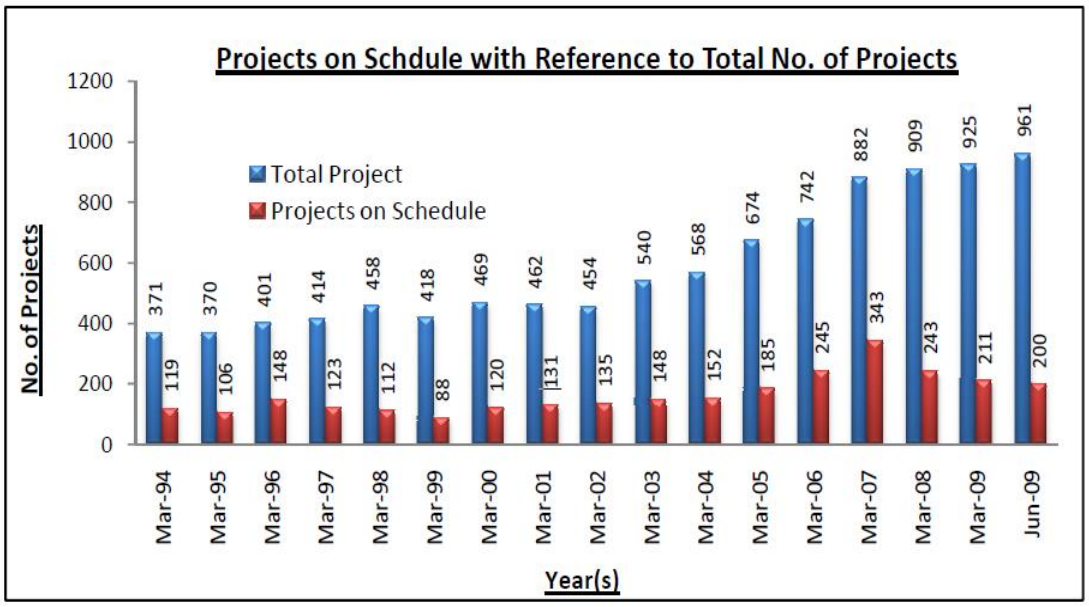
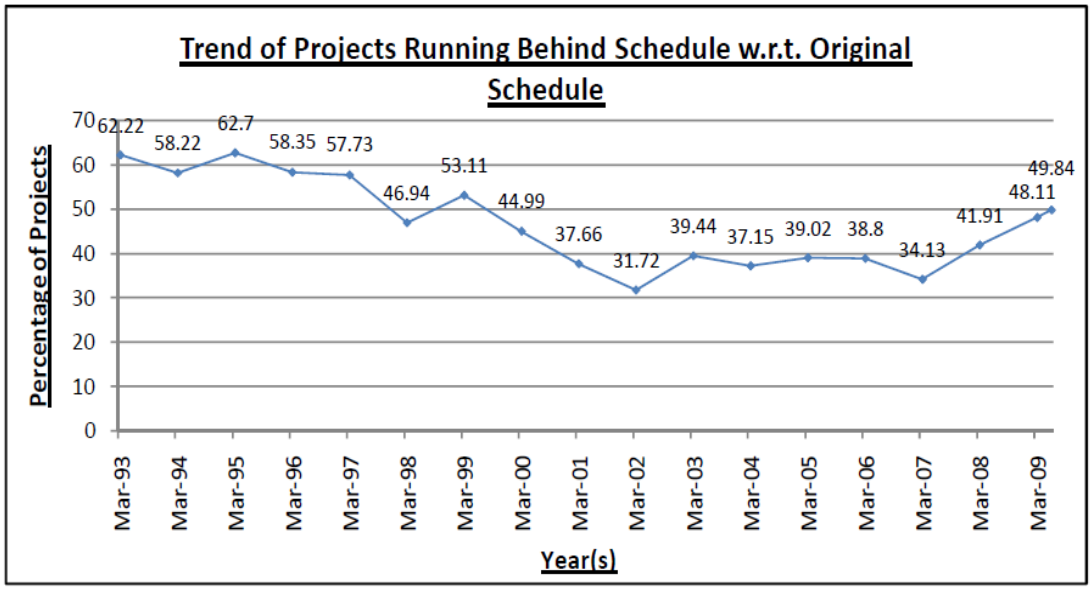


Graph 2.1: Projects on Schedule with Reference to Total Number of Projects



Trend of Projects Running Behind the Schedule with Respect to Original Schedule

➢ Assaf S. A., Al-HejjiSadiq, "Causes of Delay in Large Construction Projects", International Journal of Project Management, 24 (2006) P.P. 349-357

Surveys conducted by Assaf et al. outlined 56 main causes of delay in large construction projects. Delay factors are assembled into nine major groups with different levels of importance to different parties. There are many important causes of delay related to owner involvement, contractor performance, and the early planning and design of the project. Important causes are financial problems, changes in the design and scope, delay in making decisions and approvals by owner, difficulties in obtaining work permit, and coordination and communication problems.

➢ Chan D. W., Kumaraswamy M. M., "A Comparative Study of Causes of Time Overruns in Hong Kong Construction Projects", International Journal of Project Management, 1997; P.P. 15(1):55–63.

Chan and Kumaraswamyconducted a survey to evaluate the relative importance of 83 potential delay factors in Hong Kong construction projects and found five principal factors: poor risk management and supervision, unforeseen site conditions, shown decision making, client-initiated variations, and work variations.

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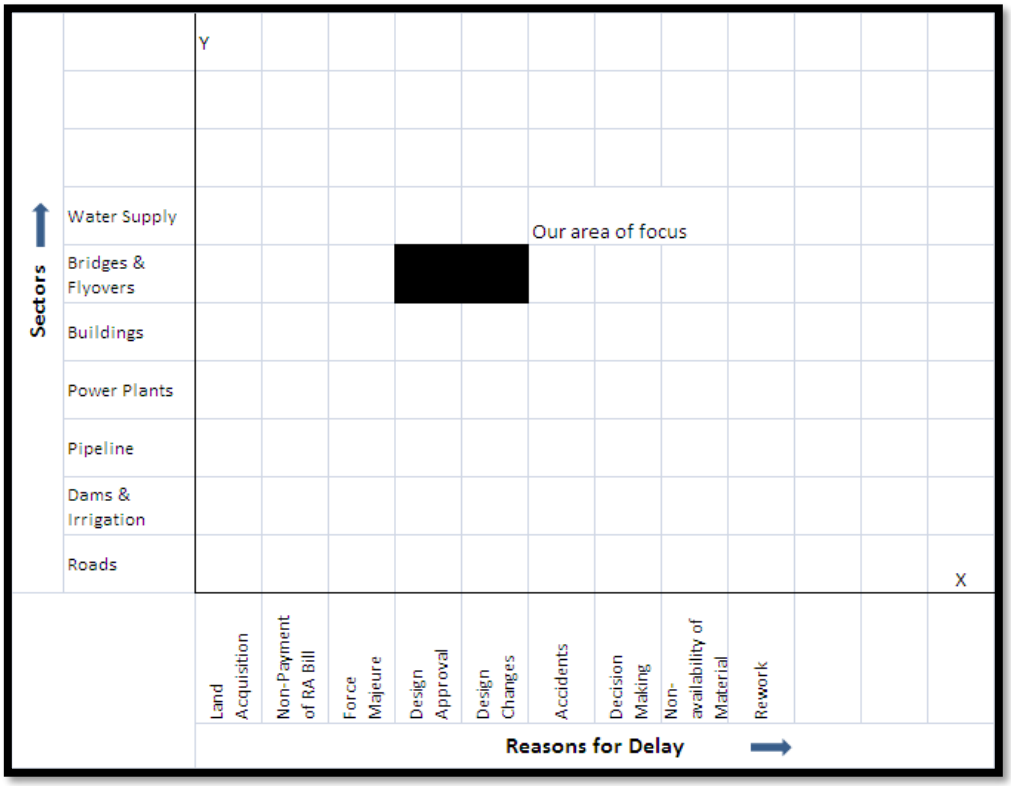
➢ Dickmann, J. E., and Nelson, M. C., "Construction Claims: Frequency and Severity", Journal of Construction Engineering & Management III (I), 1985.

Authors Dickmann and Nelson have found that the most common causes for a contract claims are design changes. A comprehensive analysis of claims indicates 46 % resulted from design change or design errors. Thus 72 % of all contract claims can be traced to design changes, extra work, and errors.

V. METHODOLOGY OF STUDY

1. We initially considered of various infrastructure sectors. At the same time we also listed out the several reasons which are commonly occurring and causing delays in these infrastructure sectors. From this, we prepared following matrix (Chart 1.1).
2. In below matrix, on one vertical axis we have listed various infrastructure sectors and on horizontal axis we have noted the reasons for delays.
3. It can be seen in the above matrix that there can be several reasons for delays in particular sector. On in other way, there can be a particular reason for occurrence of delays in various sectors.

Considering the vast nature of the delays occurring in projects, availability of the data, the timeframe available for study and analysis, we selected one sector i.e. Bridges and Flyovers. In bridges we have provided more focus on delays due to design changes and delays due to design approval.



Matrix Structure for Sectors and Reasons for Delay

➢ After This Data Collection We Are Following This Process

- Identified the projects delay, defining the delay and its types.
- Studied all activates which causes delay in project and impact of this on the project. Theoretical analysis for the same.
- Collect all the relevant data about the project.
- Analysed the data and obtained the causes of delay for the project.
- Compare all the delays and finding out its importance.

VI. COMMON REASONS FOR DELAYS IN INFRASTRUCTURE PROJECTS

1. Delays due to submission and approval of design and drawing (i.e. Delay in finalisation of detailed engineering plans, release of drawings)
2. Design changes
3. Failure to provide proper site access
4. Force Majeure Conditions
5. Labour problems
6. Delays due to issues pending with engineer
7. Lack of supporting infrastructure facilities,
8. Delay in availability of fronts,
9. Changes in scope/delay in finalization of the scope,
10. Industrial relations and law & order problems,
11. Technology problems, and
12. Geological surprises.
13. Problems with testing and commissioning, etc.

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VII. TYPES OF DELAYS

Before analyzing construction delays, a clear understanding of the general types of delays is necessary. There are four basic ways to categorize delays:

- Critical or Non-Critical
- Excusable or Non-Excusable
- Compensable or Non-Compensable
- Concurrent or Non-Concurrent
- Dependable or Non-Dependable

Different Events Classifying Excusable & Non-Excusable Delays

Excusable Delays		Non-excusable Delays	
1	Labour Disputes	1	Ordinary & foreseeable weather conditions
2	Force Majeure	2	Subcontractor's Delay
3	Unusual delay in deliveries	3	The Contractor's failure to adequately manage & coordinate the project site
4	Unavoidable delays	4	The Contractors financing problems
5	Unforeseen delays in transportation	5	The Contractor's failure to mobilize quickly enough
6	Other unforeseen causes	6	Delay by the contractor in obtaining materials
		7	Poor workmanship

VIII. CLASSIFICATION OF DELAYS

Classification of delays can also be done on the basis of a party (or parties) who are responsible for such delays. In process of settling of the claims raised by any of the party, it is very important to fix the responsibility of a party for that particular delaying event. Under this type of classification, delays are classified in following major categories

1. Delays Due to an Unbalanced Contract
2. Delays Due to Causes for which owner/ employer is responsible
3. Delays Due to Causes for which Contractor is Responsible
4. Delays Due to Causes beyond the control of both sides (Force Majeure)

IX. MODEL METHODOLOGY FOR ANALYSIS OF DELAYING EVENTS

There are a number of methodologies that may be used for the assessment of delay or prolongation, each having a number of variations. However, there is no clear legal guidance in the India as to a preferred methodology. The method used to analyse and assess delay and prolongation after a project has been completed is largely dictated by:

1. The relevant conditions of contract
2. The nature of the causative events
3. The time available
4. The record available
5. The programme information available
6. The programmer's skill level and familiarity with the project.

X. METHODS OF ANALYSIS OF DELAYING EVENTS

The main methods of analysis are set out below in ascending order of preference:

1. Global Assessment Analysis - This is not an acceptable method of analysis wherein we analyse project as a whole it respect to particular delay event

2. Impact Plan Analysis - In impact plan analysis, the original programme is taken as the basis of the calculation, and events are added into the programme to determine what the programme would have been had those events been taken into consideration.

3. Collapsed As-build Analysis - In collapsed as-build analysis, the effects of events are 'subtracted' from the as build programme to determine what would have occurred but for those events.

4. Window Analysis - In window analysis, the project, for the purposes of analysis, is divided into number of consecutive time 'windows', and delay occurring in each of the window is analysed and attributed to the events occurring in that window. This method is merely a development of time impact analysis.

5. Time Impact Analysis - In time impact analysis, the impacts of particular events are mapped out at the point in time at which they occur, allowing the discrete effect of individual event to be determined. Ideally this analysis is carried out continuously throughout the contract period to allow real-time assessment of delays and the impact of changes; this allows the likely date for completion of the works to be kept under review, and helps to avoid dispute developing. In a dispute situation, analysis is frequently carried out after the works have been completed. In this situation, time impact analysis should be used wherever possible, while recognizing that establishing the progress of the works at each significant date can be a costly and time-consuming operation if proper records have not be kept in a suitable format.

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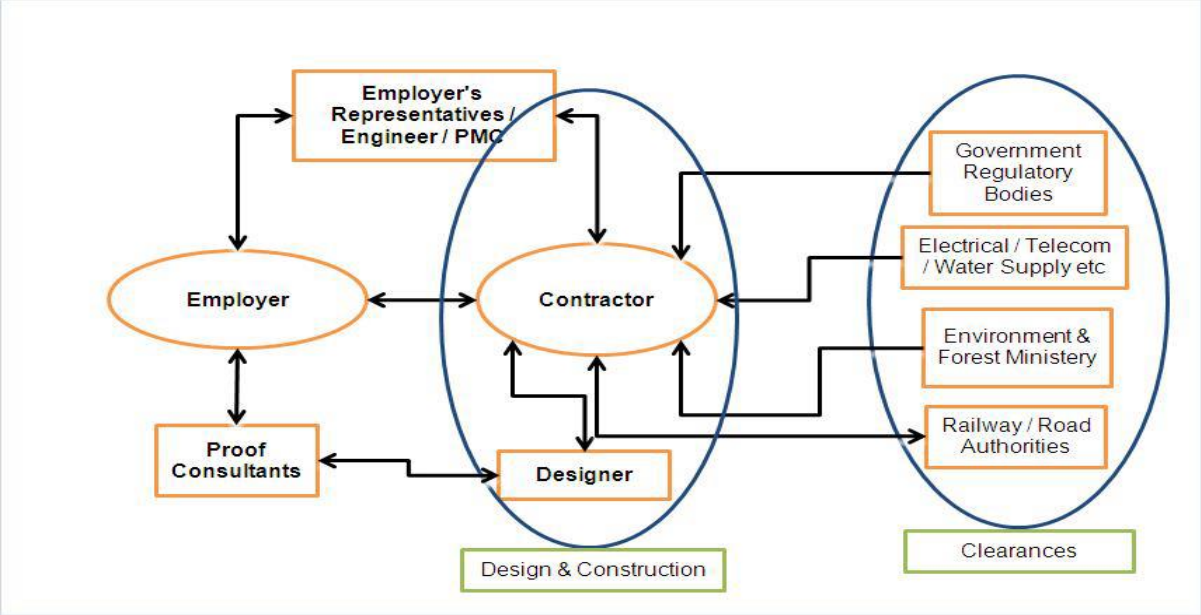
XI. DESIGN SUBMISSION AND APPROVAL MECHANISM IN DESIGN AND BUILD OR EPC TYPES OF CONTRACTS

In this type of contracts, client provides basic requirements to the contractor. Based on that contractor prepare designs and drawings and submit those to client or his representatives for further checking and approval.

Contractor takes total responsibility for the design and execution of the project, with little involvement of the Employer. Under the usual arrangements for turnkey projects, the Contractor carries out all the Engineering, Procurement and Construction (EPC): providing a fully-equipped facility, ready for operation (at the "turn of the key").



Parties involved in D&B / EPC Contracts

Following steps are involved in the design submission and approval mechanism.

1. The design and drawings are either prepared by contractor through his in house design team or through outsourcing it from some expert design agency (also called as design consultants). Generally such revision of drawing is known as R0 revision.

2. The designs and drawings are then forwarded to client or his representatives i.e. Engineer. Engineer reviews the design and if found satisfactory, he may accord 'Initial Approval'. But if engineer notice any correction or discrepancy or if he has any doubts, then same are brought to the notice of contractor. In such cases, the designs & drawings are then returned to contractor with comments from engineer.

3. After receiving the comments from engineer, contractor makes necessary corrections or alterations or changes in earlier revision of drawings. The revised drawings are then forwarded to engineer. Now this successive revision of drawing is called as 'R1' revision.

4. The cyclic process as mentioned in step 2 and step 3 are repeated unless and until engineer gives 'Final Approval' to that particular drawing.

5. There may be some drawings which got 'Initial Approval' at R0 revision and subsequently 'Final Approval' at R1 Revision. On the contrary, there may be some drawings for which checking and approval continues upto R10 revision. Each stage of checking and correcting of drawings may require considerable time which caused delays in projects.

6. If a particular contract demands third party checking or proof consultants for checking and approval of designs and drawings, the drawings are forwarded to such third party or proof checking consultants after initial scrutiny by engineer. In this particular approach, after step 2, design and drawings are forwarded to such third party or proof consultants for further checking and approval. If such third party or proof consultants notice any correction or discrepancy or if they have any doubts, then same are brought to the notice of contractor and the designs & drawings are then returned to contractor with comments. The design and drawing then again have to follow the cycle as mentioned in step 3, unless and until final approval is not being accorded by third party or proof consultants to that particular design and drawing.

7. If a project or any part of a project is passing through railway land, forest land, defense land etc, then the design and drawings for that portion of project may require approval from respective agencies. It is a common practice adopted at site that contractor starts construction activities at his own risk and cost, immediately after receiving 'Initial Approval'. Simultaneously, he does necessary corrections or alterations or changes in 'Initially Approved' drawings to fulfill the requirements for 'Final Approval'. Chart

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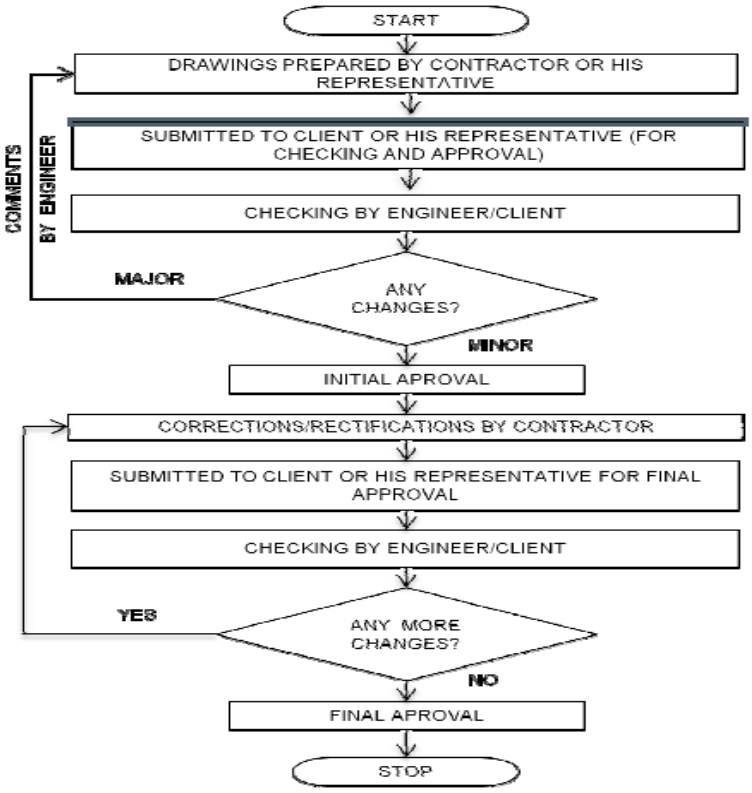

Process of design submission and approval in D&B / EPC Contracts

XII. DESIGN SUBMISSION AND APPROVAL MECHANISM IN CONVENTIONAL / TRADITIONAL TYPE CONTRACTS

In case of traditional or conventional contracts, client or his representatives prepares design and drawing and forward it to contractor for further execution. In this case, client either prepares design and drawings through his in-house design team or client may appoint separate design consultants for this purpose. If such separate design consultants are appointed for designing purpose then client will approve the drawings submitted by such consultants. Such approved drawings are then released to contractor for further construction. The drawings are generally released in stage wise manner as per the construction sequencing or schedule for which both parties (client and contractor) have agreed initially. The risk of delay in this case mainly lies with client no matter whether the delays in design and drawing have caused by client's in-house design team or by separate design agency which he had appointed. Further it is also responsibility of the client to get approvals to all such design and drawing from other project associated bodies and concerned departments who are directly or indirectly connected with the project, like Railways, local municipal council; and client are accountable for any delays in this process (See Figure 4.2). As the design and drawings are prepared by client (or his representatives), and therefore the chances for further corrections in such drawings will be very less.

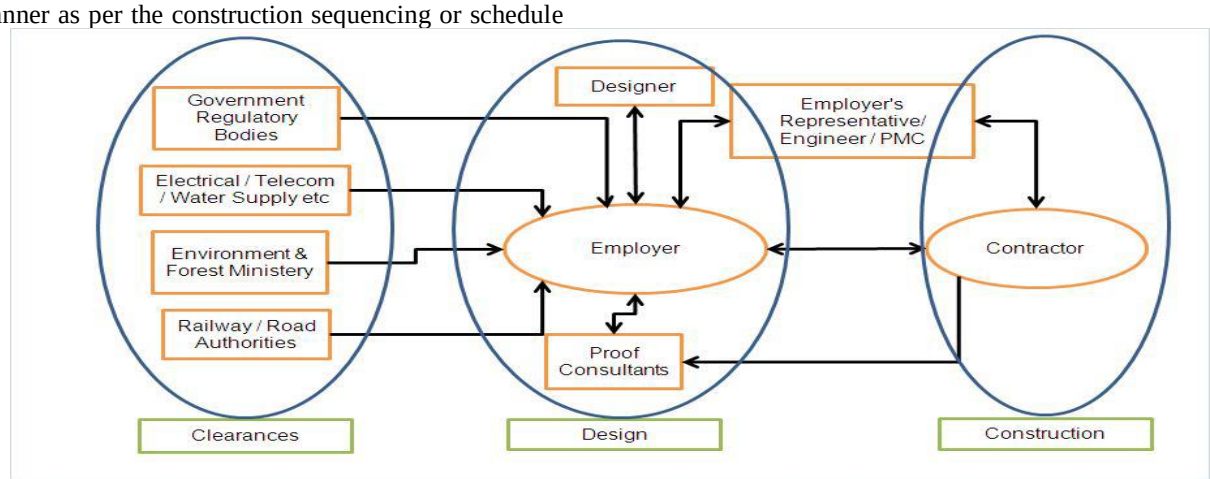

Figure 4.2 : Parties involved in Traditional Construction Contracts

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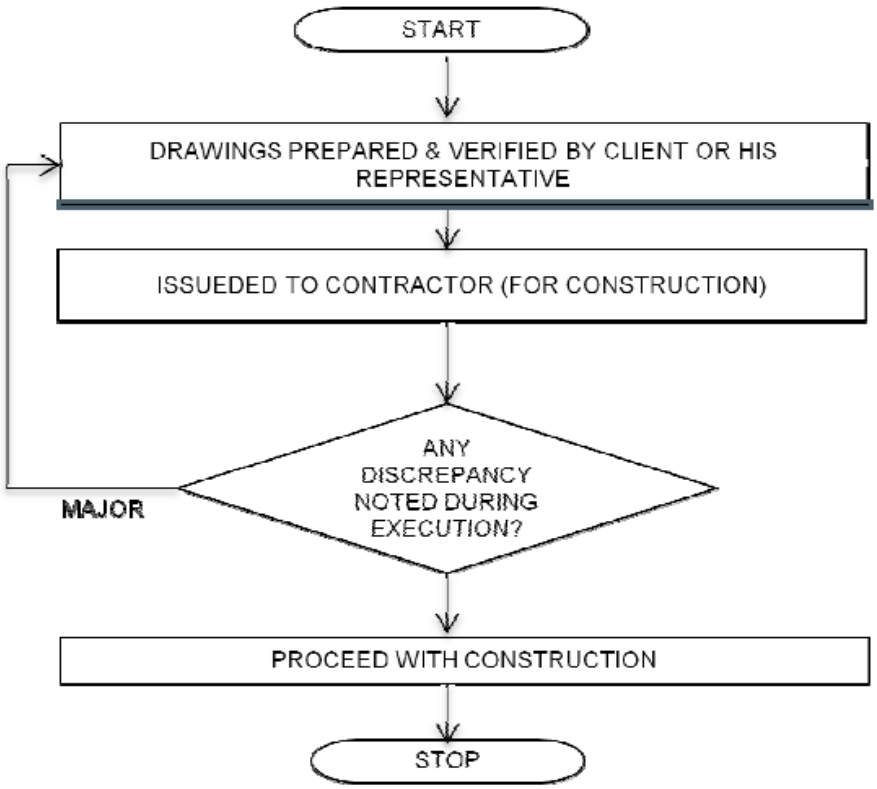
Following steps are involved in the design submission and approval mechanism.

1. Drawings are prepared by client or his representatives (i.e. Engineer) either through their in-house design team or through outsourcing it from some expert design agency (also called as design consultants).

2. After necessary checking and verification at client's end, drawings are released or issued to contractor for undertaking construction work. Client may appoint separate proof consultants for checking and approval.

3. If any discrepancy or error is noted in the later stage by either by contractor or by engineer or by client himself, then such discrepancy or error is removed and necessary correction or alteration is made in the respected drawings.

In this type of design approval mechanism, scrutiny is not required as the drawings prepared by client or his representatives only and therefore the delays associated with design and drawing approval will not occur. The delays due to late release of drawing may come in to picture in such type of contracts. (See Chart 4.2)



Process of Design Submission and Approval in Traditional Contracts

XIII. DELAYS DUE TO DESIGN CHANGES IN BRIDGES

FACTORS CAUSING DESIGN CHANGES

1. Difference in assumed subsoil condition and actual subsoil condition
2. Increase or decrease in the scope & nature of work
3. Non-availability of construction material
4. Impossible to construct with earlier design
5. Position of a particular structural element changed due to underground/overground hindrances
6. Client's requirements

XIV. TYPES OF DESIGN CHANGES

- Based on Nature
- Based on Time of Occurrence
- Based on Components of Bridge
- Based on Time Required
- Based on Other Factors
- Precautions to be Taken to Avoid Delays Due to Design Changes

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XV.CASE STUDIES

Basic Details of Project

Sr. No.	Basic Information	Details of Project
A	Basic Information about the Project	
1	Name of the Project:	Flyover Interchange cum ROB
2	Address of the Project:	Major City in Maharashtra
3	Name and address of Client:	A Govt. of Maharashtra Undertaking company
4	Name and address of Consultant:	PQR
5	Name and address of Contractor:	ABC
6	Contract Price of Project:	Rs. 68.64 Cr.
7	Project Duration:	18 Months
8	Type of Contract:	Lump sum (Design and Build)
9	Type of Bridge / Flyover:	Flyover Interchange cum ROB
10	Type of Structure:	There is a great variety as far as Structures are concern
a)	Foundation:	Trapezoidal Footing, Pile Foundation, Raft Foundation
b)	Substructure:	Cast in-situ
c)	Superstructure:	Precast PSC Box Girder, Cast In-situ Box Girder, Precast I girder, Voided Slab
B	Information about the delays in Project	
1	Date of Commencement:	21-Sep-06
2	Date of Completion (As per Contract):	20-Mar-08
3	Current Status of Project:	100% Completed
4	Date of Completion:	31-Mar-11
5	Total Delays in project (Overall):	3 Years (approx.)
C	Information about the Design & Approval of the Project	
1	Responsibility of the Design and Approval:	With Contractor
2	Approving Agency:	---
a	For Non-Railway Portion:	Only Project Management Consultants (PMC)
b	For Railway Portion:	At First Stage, Project Management Consultants (PMC), At Second Stage, Railway, And at third stage, Third Party /Proof Checking for Railways (i.e. By IIT Mumbai)

- Period Under Consideration for Analysis of Delay Upto 20-Feb-10

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Sr. No.	Description of Delay (Or Reason for Delay)	Responsible Party	Current Status of Delaying Event	Start of Delaying Event	End of Delaying Event	Total no. of Days of Delay
A	Delays related to Design Changes and Design Approval					
1	Delay in Approval of GAD	Engineer	Completed	21-Sep-06	09-Dec-06	79
2	Delay in Approval of Pier, Piercap and foundation	Engineer	Completed	04-Dec-06	29-Feb-08	452
3	Delay in Approval of Superstructure (Box Girder)	Engineer	Completed	25-Jan-07	29-Feb-08	400
4	Delay in Approval of Bearing	Engineer	Completed	12-Mar-07	29-Feb-08	354
5	Delay in Approval of Abutment	Engineer	Completed	03-May-07	29-Feb-08	302
6	Delay in Approval of Voided Slab	Engineer	Completed	29-Mar-07	29-Feb-08	337
7	Delay in Approval of RE Wall	Engineer	Completed	06-Mar-07	06-Jun-07	92
8	Delay in Approval of Friction Slab	Engineer	Completed	15-Nov-07	06-Dec-07	21
9	Delay in Approval of Railway Drawings	Engineer + Central Railway	Waiting for Approval	15-May-07	20-Feb-10	1012
10	Delay in Approval of Pier Shape	Engineer	Completed	03-Oct-06	06-Jul-07	276
11	Delay in Foundation Level	Engineer	Completed	31-Oct-06	15-Mar-07	135
12	Delay in approval of drawing of Ramp A Portion	Engineer	Completed	07-May-09	20-Feb-10	289
13	Delay in Approval of I Girder Drawing	Engineer	Completed	24-May-07	11-Jul-08	414
14	Delay in Approval of Anti-Crash Barrier Drawing	Engineer	Completed	24-Jun-08	05-Oct-09	468
15	Delay in Approval of Expansion Joint Drawing	Engineer	Completed	14-Dec-07	11-Mar-09	453
16	Delay in Approval of Pier Protection Works	Engineer	Completed	09-Mar-09	06-Oct-09	211
B	Delays other that Design related issues					
1	Delay in Tree Cutting and utility shifting in Railway area	Engineer + Central Railway	Completed	21-Sep-06	18-Jan-08	484
2	Agitation by Local Villagers / Stoppage of Work	Force Majeure		12-Dec-06	23-Dec-06	11
3	Delay in Approval of Electrical and Telephone line shifting (Non-Railway Portion)	Engineer	Completed	06-Nov-06	20-Feb-10	1202
4	Delay in Tree Cutting of Non-Railway Portion	Engineer	Completed	21-Sep-06	13-Dec-06	83
5	Delay in giving decision for change of foundation type	Engineer	Completed	04-Oct-06	14-Mar-07	161
6	Delay in Handing over of Ramp A Portion	Engineer	Completed	09-Dec-06	04-May-09	877
7	Delay in Load Test	Engineer	Completed	31-Mar-09	11-Dec-09	255

Details of bridge

a. Length of main Flyover - 1580 m

b. Length of Main viaduct - 1250 m (Including ROB)

c. Approach - 160.0 m

d. Length of ROB - 118.6 m

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XVI. CONCLUSIONS

1. Delays in construction projects are inevitable. They occur in projects in some or the other form. We cannot avoid occurrence of many delaying events completely but we take precautionary measures such that the effects resulted out of these will be bare minimum.
2. In Indian construction scenario, about 49.84% projects are running behind the schedule which is one of the major hurdles for sustaining higher growth in this sector.
3. There is no any specific literature which speaks about the delays in bridge construction only. At the same time there is no any literature which has covered the delays due to design changes or due design approval.
4. One of the major reasons for time overrun in infrastructure projects, especially bridges is the delay in approval of design and drawing. If such approval is not accorded in time it may lead many dependable delays. And chain effect of delaying events came in picture.
5. As far as possible, Design change should be the last option from both client as well as contractor. Design changes also produce a multitude of other negative impacts, such as low morale, quality discrepancies, and legal disputes.
6. Some of the factors which contributes to design change are difference in assumed subsoil condition and actual subsoil condition, Increase or decrease in the scope & nature of work, Non-availability of construction material, Impossible to construct with earlier design, Position of a particular structural element changed due to underground/over-ground hindrances etc
7. During actual course of execution, it may be noted that there is a vast difference between what is assumed during design and what actual site conditions are.
8. Ego of the parties is most dangerous to the timely and cost effective completion of any project. Both the client and contractor have to work in the spirit of give and take and try to accommodate each other to the extent possible.
9. A rational interpretation and display of accommodative spirit by both parties (i.e. Client and contractor) to a contract could pave the way for a smooth and timely execution of the work.

XVII. RECOMMENDATIONS

1. Experienced design engineers can be posted at the site to take immediate decisions in case of minor problems and to liaise with the field staff and the central design office for major problems.
2. Looking to the backlog of the projects and the performance of the projects that have already been completed, it was felt that a closer scrutiny of all the projects should be made to ensure that adequate data is collected and used in the project formulation. The designated authorities have now issued general guidelines on the data requirements and their analysis and incorporation in the Project Reports to ensure that all requisite details are collected and presented for examination and analysis.
3. The period of execution of the project has to be scientifically determined considering every aspect so that there are no delay and consequent cost overruns.
4. The role of the drawings is to define the geometry of a project, including dimensions, forms and details.
5. The time allowed for completion of contracts should be realistic keeping in mind various factors like availability of material, facilities of transportation etc. Instead, the time available for completion of project is based on the wishes of the clients and not necessarily on the scientific evaluation of the scope of the work.
6. The project shall be planned and designed after carrying out all necessary investigations so that changes in project features do not occur during construction and if at all hey occur, they are not of much significance.
7. Keeping in view the common objective of time, cost and quality, it is very important that cordial relations and proper understanding is always maintained between the employer and the contractor for the successful completion of project.

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AUTHORS

First Author – Patel Hetal M, M.Tech (Civil-Construction Project Management), Parul Institute of Technology,

Second Author – Tushar M. Maniya, B.E. Civil, Civil Department (Shree Dhanvantary Collage of Diploma Engineering, Kim-Surat),