Research Paper Engineering

Factors Causing Performance Delays of Deep Foundation Construction Projects in Vicinity of River

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ABSTRACT

Construction industry - considered to be one of the complex industries in its nature because of involvement of large number of parties such as clients, consultants, contractors, sub-contractors, shareholders, financers and others. Failing to understand this complexity in India, is leading an increase in the number of construction projects experiencing extensive delays further leading to exceeding the time and cost budget from initially proposed ones. This paper deals with identifying and evaluating the main factors affecting performance delays in deep foundation construction projects in proximity of River. In this paper the construction projects discussed are in area strip in proximity of Yamuna River in Delhi. The intention is to gather the valid causes for delay of project and giving some recommendation for mitigation of these factors. With the help of Literature review and other local experts factors affecting the performance of ground water construction projects were identified, 60 factors were identified, evaluated and ranked from clients, consultants, constructors and sub-contractors perspectives. 36 questionnaires were distributed as follows: 6 to client and consultants, 24 to contractors and 6 to major sub-contractors. Data collected were analyzed by frequency, severity and importance indices. The member of survey were from various reputed government offices and various construction industries who have experience in execution of such kind of projects.

KEYWORDS Groundwater project, deep foundation, cost risk, delay time, vicinity of river.

INTRODUCTION

Construction industry is majorly responsible for development and upliftment of infrastructure of any developing economy. It is considered one of the largest industries of any developing economy and contributes to about 10-12 % of the National GDP (Navon, 2005). But then also construction industry is considered to be complex industry because of involvement of large number of parties i.e. clients, contractors, sub-contractors, consultants, stakeholders, shareholders and regulators. The performance of construction industry of any country is affected by national economy, because the biggest customers for construction industry in most countries are government agencies (Okpala and Aiekwu, 1988). Efficient construction projects can provide a solid platform for reviving the economy and infrastructure of developing nations and building a more balanced and independent economy during stable political conditions.

In recent years, Indian government has played an active role in promoting and supporting construction industry in every way in order to improve the infrastructure of country. But this increase in infrastructure projects was accompanied by some problems also i.e. project delays, insufficient funds, improper working of concerned government departments, improper performance of construction companies during the construction of any project. Performance of any construction project is related to many topics and factors such as time, cost, quality, client satisfaction, productivity and safety. To dislike of owner, contractors, consultants and sub-contractors many government projects experience extensive delays and thereby exceed the initial time and cost estimates (Odeh & Bataineh, 2002). In construction industry delay could be defined as the time overrun either beyond completion date specified in a contract, or beyond the date the parties have agreed upon for delivery of project or in other words it is a project slipping over its planned schedule and this problem is more evident specially in government construction projects because no. of external factors in government projects. Few of many realistic reasons for delay of government projects in developing countries are poor management and leadership; inappropriate participants; poor relations and coordination; absence of motivation, control, monitor or decision making systems; inadequate infrastructure, political problems; cultural problems and economic conditions. When projects are delayed they are either extended or accelerated and therefore incur additional cost. These have a deliberating effect on contractors and consultants in terms of growth in adversarial relationships, mistrust, litigation, arbitration, cash-flow problems, and a general feeling of trepidation towards other stakeholders (Ahmed et al., 2002). Indeed, the problem of time and cost overruns in India is widespread and very severe. The study investigates the issues related to delays, cost overrun and failure of deep foundation projects having high ground water level.

RESEARCH OBJECTIVE:

This research principally aims on analysis of factors (from literature review as well as from local experts) affecting the performance of Deep foundation construction projects in areas which are in vicinity of rivers or the areas having aquifers at less distance from natural ground level (NGL). Further, the principal aim of this research can be broken down into the following objectives:

1. To identify the factors affecting the performance of deep foundation construction project.
2. To determine owners, consultants, contractors and major sub-contractors perceptions towards the relative affect of delays affecting the performance of under consideration in order to evaluate its performance.
3. To Test the validity and reliability of questionnaire by means of which the data has to be collected for analysis.
4. To analyze the data collected by means of questionnaire and rank the delay causes using importance index (%).
5. To recommend some suggestions to improve the performance of construction projects.

PREVIOUS RESEARCH WORKS

Construction projects are unique and temporary in nature and so is their management. PMBOK 2003 defines project management as the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. The project requirements or objectives vary from project to project and person to person. The factors also referred to as "attributes" in some literature responsible for achievement of these requirements and the attributes obstructing the achievement of these requirements have fascinated the researchers since the 1960s.

A study conducted by Infrastructure & Project Monitoring Division of Ministry of Statistics and Program Implementation http://www.mospi.nic.in reports that out of 646 central sector projects which are of the order of more than $4.45 million costing around $50 trillion and average project duration of 6 to 7 years, about 40% are behind schedule and the delay ranges from 1 to 252 months. The schedule overrun in percentage terms as on December 2003 was reported to be 40.23% while the figure for the same as on December 2004 was reported to be 39.9% (Iyer and Jha, 2006).

Avots 1969 concludes that choice of wrong project manager, the unplanned project termination, and unsupportive top management are the main reasons for project delay / failure. Hughes 1986 in another study identifies that projects are delayed because of improper basic managerial principles such as improper focus of the management system, rewarding the wrong actions, and the lack of communication of goals. Chitkara 1998 points out inadequate project formulation and the improper management of the projects as the primary reasons for project delays / failures.

Schultz et al. 1987 classify critical success factors in two groups and conclude that these groups affect project performances at different phases of

Factors
(7) People factors
Employee attitudes in project
Recruitment and competence development between employees
Employees motivation
Belonging to work
(8) Health and Safety factors
Application of Health and safety factors in organization
Easiness to reach to the site (location of project)
Reportable accidents rate in project
Assurance rate of project
(9) Innovation and learning factors
Learning from own experience and past history
Learning from best practice and experience of others
Training the human resources in the skills demanded by the project
Work group
Review of failures and solve them
(10) Environment factors
Air quality
Noise level
Wastes around the site
Climate condition in the site
(4) Productivity factors
Project complexity
Number of new projects / year
Management-labor relationship
Absenteeism rate through project
Sequencing of work according to schedule
(5) Client Satisfaction factors
Information coordination between owner and project parties
Leadership skills for project manager
Speed and reliability of service to owner
Number of disputes between owner and project parties
Number of reworks
(6) Regular and community satisfactio
Cost of compliance to regulators requirements
Number of non compliance to regulation
Quality and availability of regulator documentation
Neighbors and site conditions problems

Factors
(2) Time factors
Site preparation time
Planned time for project construction
Percentage of orders delivered late
Time needed to implement variation orders
Time needed to rectify defects
Average delay in claim approval
Average delay in payment from owner to contractor
Availability of resources as planned through project duration
Average delay because of closures and materials shortage
(3) Quality factors
Conformance to specification
Availability of personals with high experience and qualification
Quality of equipments and raw materials in project
Participation of managerial levels with decision making
Quality assessment system in organization
Quality training/meeting

Fig. 1 Few of the Delay Factors Collated from previous journals

implementation. The first group is referred to as the strategic group that consists of factors like project mission, top management support, and project scheduling. The other group is the tactical group, which consists of factors like client consultation and personnel selection and training.

Chan and Kumaraswamy (1997) reported five principal causes of time overruns perceived among clients, contractors, and consultants in Hong Kong construction projects. The five most significant sources of delay were poor site management and supervision, unforeseen ground conditions, low speed in decision-making, client-initiated variations, and design change.

Frimpong et al. (2003) identified five key factors that impact project delays. These factors are monthly payment difficulties from agencies, poor contractor management, material procurement, poor technical performance, and escalation of materials prices. Although a general consensus of the impacts of these factors on cost performance was found among clients, con- tractors, and clients, a significant contrast was highlighted on the issues reported previously (Baloi and Price 2003; Skitmore and Wilcock 1994).

Realistic 'construction time' has become increasingly important it often serves as a crucial benchmark for assessing the performance of a project and the efficiency of the contractor (Ramanathan and Narayanan, 2012). The Delay factors in construction industry are collated from previous related research articles and grouped. There are 111 distinct delays factors responsible for delay of a construction project through critical review of 20 previous research studies performed in the relevant field. This gives all the combination of factors and categories responsible for construction delays. But this critical review of 20 studies also demonstrates that none of the studies can be generalized and directly applicable 'as is'. This presents a strong case against opinion surveys when as in this case, as this project (under consideration) in vicinity of river i.e. it has less distance of aquifer from NGL and the project requires deep excavation to be carried out, therefore the causes of delay slightly differ. Few delay factors collated from previous research studies are shown in following Fig.

Reasons Behind Extended Durations		
	2012	2011
Initial Project Scope was Extended	29%	17%
Organizational Issues	20%	14%
Data Issues	17%	14%
Resource Constraints	17%	13%
Training Issues	15%	10%
Technical Issues	14%	7%
Conflicts in Priority of Project	12%	10%
Unrealistic Timeline	11%	8%
Vendor Functionality Issues	4%	8%

Fig. 2 Some Typical Reasons Responsible for project delay.

RESEARCH METHODOLOGY

This research chiefly focuses over performance of Deep Foundation Construction projects in vicinity of rivers or areas having high aquifers / water table. Through thorough literature review and discussions with local experts involved with construction industry a total of 60 causes were identified which were mainly affecting the performance of construction projects and causing them to delay / effect the performance of project. A questionnaire was developed in order to evaluate the frequency of occurrence, severity and importance of the identified. The main methodologies obtained from literature review were: - Questionnaire survey, interviewing, case study and modeling. The basic methodology which is considered to achieve the objective of this research is as the following issues: -

3.1.1 Concerning Objective one: - (To identify the factors affecting the performance of construction project under consideration):

3.1.2 Concerning Objective two (Questionnaire Design): -

3.1.3 Concerning Objective three (To test the Reliability and Validity of the Questionnaire):

3.1.4 Concerning objective four (To analyze the data and evaluate the Importance Index (%) and to identify most important causes of delay from importance index evaluated): -

The response to the data is collected with the help of questionnaires is analyzed. Following statistical techniques and indices are used for performing analysis:

- Frequency Index: This the formula which is used to rank causes of delay based on frequency of occurrence as identified by the participants.
- Frequency Index (%) = (∑ (a n) ÷ N) x (100 ÷ 5)
- Where a is the constant expressing weighting given to each response (range from 1 for not at all up to 5 for always), n is the frequency of the response, and N is the total number of responses.
- Severity Index: This formula is used to rank causes of delay based on severity of occurrence as identified by the participants / respondents.
- Severity Index (%) = (∑ (a n) ÷ N) x (100 ÷ 5)
- Where a is the constant expressing weighting given to each response (range from 1 for no importance up to 5 for extreme), n is the frequency of the response, and N is the total number of responses.
- Importance Index: The importance index of cause is calculated as a function of both frequency and severity indices, as follows:
- Importance Index(I.I %): (Frequency Index % X Severity Index %) ÷ 100

3.1.5 Concerning Objective five (To formulate recommendations to minimize and control delays in Deep Foundation construction projects in vicinity of rivers or on areas having high water tables).

Questionnaire Form: This questionnaire consists 62 causes of delay on which a detailed analysis was carried out by using statistical concept with the help of SPSS software. These causes were classified into nine groups according to the sources of delay: Factors related to projects, owner, contractor, consultant, design-team, materials, equipment, manpower (labour), and external factors. As the survey was conducted on the conditions of secrecy because of high level government offices like Ministry, CPWD, DMRC, Chief Justice's office, and other highly reputed government agencies involved. Only the party of respondent (i.e. Owner/ client, contractor, consultant, and sub-contractors), experience and their main scope on project site was allowed to be disclosed. According to "Builder Association of India" and Contractor list from office of DMRC and CPWD and Delhi State PWD there were 80 contractors, 20 Sub-contractors who were doing or have done similar kind of projects and 20 officials from CPWD, DMRC and Delhi PWD Department who are working or have worked as clients and consultants for the type of project under consideration making a total population of 120 for analysis. For selection of sample size stratified Random Sampling technique was used in this research paper.

Frequency of Occurrence

- Always (5): Generally occurs in all the projects (70%-100%).
- Often (4): Occurs in 5 to 7 projects out of 10 i.e. 50% -70%.
- Sometimes (3): Occurs in 1 to 5 projects out of 10 i.e. 10% -50%.
- Rarely (2): Occurs only 1 time out of 10 Projects i.e. >10%.
- Not at all (1): Does not occur in any project i.e. 0%.

Fig. 3 Frequency Scale Used

Degree of severity

- Extreme (5): Greater than 50% increase in cost and time of project.
- Great (4): 25%-50% increase in cost and time of project.
- Moderate (3): 10%-25% increase in cost and time of project.
- Little (2): Less than 10% increase in cost and time of project.
- No significance (1): No effect on cost and time of project.

Fig. 4 Severity Scale

Sample Size Calculation:

- n= ∑ ni
- ni=n.Pi
- Pi=Ni / N
- Where, n= required sample size, ni = sample size from particular strata, Pi = proportion of population included in the stratum i, Ni = population of I strata, N = total population.

For strata with N_1 =80, we have P_1= 80/120, And hence n_1 = n . P_1 = 36 x (80/120) = 24, similarly, n_2= 6 and n_3 = 6. Therefore n = 36 (sample size).

Item	Extreme Importance	Great Importance	Moderate Importance	Little importance	No importance
Scale	5	4	3	2	1

Fig. 5 Ordinal (Likert) Scale Used for Measuring Response.

The nine Categories of delay are: Delay at Project level; Delay due to Owner; Delay due to contractor; Delay due to consultant; Delay due to Designer; Delay due to Material Delay due to Equipment Delay due to labour / Manpower Delay due to External factors.

No.	Causes of Delay	Group	Frequency Index (%)	Severity Index (%)	Importance Index (%)
1	Original contract duration imposed too short	Project Group	60	68.89	41.33
2	Late Handover of Site from LOA		43.89	53.89	23.65
3	Ineffective Delay penalties		44.44	53.89	23.95
4	Legal disputes between various parts		53.89	62.22	33.53
5	Type of Project bidding and award (negotiation, lower bidder)		48.33	62.78	30.34
6	Type of construction contract (Turnkey, construction only)		39.44	68.89	27.17
7	Delay in progress Payment by client	Owner Group	56.11	67.22	37.72
8	Excessive variations in project by client		53.89	54.44	29.34
9	Late in revising and approving design documents by owner.		66.11	69.44	45.91
10	poor communication and coordination by owner and other parties		60	69.44	41.67
11	Slowness in decision making process by client		63.33	57.22	36.24
12	Conflicts between joint ownership of the project.		47.22	57.22	27.02
13	Suspension of work by owner		46.67	65	30.33
14	Difficulties in financing project by contractor	Contractor Group	53.89	83.89	45.21
15	Conflicts in subcontractors schedule in execution of the project.		58.89	53.89	31.73
16	Rework due to errors during construction		63.33	69.44	43.98
17	Conflicts between contractor and other parties (Consultant and owner)		58.89	53.89	31.73
18	Poor site Management and supervision by the contractor		63.89	82.22	52.53
19	Poor communication and coordination by contractor and other parties		56.11	57.22	32.11
20	Ineffective planning and scheduling of project by contractor.		70.56	69.44	49
21	Improper construction methods implemented by contractor.		43.89	67.22	29.5
22	Delay's in sub-contractor's work		45	58.89	26.5
23	Poor qualification of the contractor's technical staff		68.33	53.89	36.82
24	Delay in site mobilization		45.56	54.44	24.8
25	Delay in performing inspection and testing by consultant	Consultant Group	54.44	58.89	32.06
26	Delay in approving major changes in the scope of work by consultant		55	54.44	29.94
27	Inflexibility of consultant (Rigidness)		45.56	67.22	30.62
28	Poor communication/ coordination between the consultant and other parties.		62.22	57.22	35.6
29	Late in reviewing and approving design documents by consultant		51.67	53.89	27.84
30	Conflicts between consultant and design engineer		68.33	57.22	39.1
31	Inadequate experience of consultant		60	68.89	41.33

32	Mistakes and discrepancies in design documents	Design Group	47.22	53.89	25.45
33	Complexity of Project design		52.78	58.89	31.08
34	Insufficient data collection and survey before design.		56.11	82.22	46.14
35	Inadequate design team experience		39.44	57.22	22.57
36	Un-use of advanced engineering design software.		43.89	53.89	23.65
37	Shortage of construction material in market	Material Group	63.89	53.89	34.43
38	Changes in material type and specification during the construction		58.33	57.22	33.38
39	Delay in material delivery		59.44	54.44	32.36
40	Shortage of material while they are needed urgently on construction site.		60	69.44	41.67
41	Late procurement of materials		58.33	53.89	31.44
42	Equipment Breakdowns	Equipment Group	64.44	53.89	34.73
43	Shortage of Equipments		51.67	54.44	28.13
44	Low level of equipment-operator's skill		45.56	69.44	31.64
45	Low productivity and efficiency of the dewatering equipment		66.67	82.22	54.81
46	Lack of high technology mechanical equipment		51.67	69.44	35.88
47	Failure of Dewatering Pumps		70.56	83.89	59.19
48	Generator set / Power Failure		65	62.22	40.44
49	Shortage of labor	Labour Group	43.89	53.89	23.65
50	Low Productivity level of labor		56.67	53.89	30.54
51	Personal conflicts among labors		45	57.22	25.75
52	Effects of subsurface conditions (e.g. Soil, High water table)	External Factors	63.33	83.89	53.13
53	Delay in obtaining permits from concerned authorities		43.89	57.22	25.11
54	Inclement weather		68.33	53.89	36.82
55	Rain effect on construction activities		82.22	53.89	44.3
56	Effect of social and cultural factors		45.56	58.89	26.83
57	Accident during construction		62.22	53.89	33.53
58	Different site(ground) conditions		68.33	62.78	42.9
59	Delay in providing urgent permissions		65	57.22	37.19
60	Delay in performing final inspection and certificate by a third party.		39.44	58.89	23.23

Table 1 Results of Data Analysis

ANALYSIS AND RESULTS

The Cronbach's coefficient alpha was calculated for each factor group of the questionnaire. The most identical values of alpha indicate that the mean and variance in the original scales do not differ much, and thus standardization does not make a great difference in alpha.

Fig. 6 shows the values of Chronbach's alpha for each field of the questionnaire and the entire questionnaire. For the factor groups, values of Chronbach's alpha were in the range from 0.741 and 0.929. This range is considered high; the result ensures the reliability of each field of the questionnaire.

Chronbach's Alpha equals to 0.973 for the entire questionnaire which indicates an excellent reliability of the entire questionnaire. Thereby, it can be said that it is proved that the questionnaire is valid, reliable, and ready for distribution for the population sample.

For this research Spearman's rank correlation coefficient test was done to find the validity of the delay factor groups. Spearman's rank correlation coefficient showed both divergent and convergent validity and correlation for each group between the causes of delays in each group. Correlation table is shown in fig. 7 for understanding when two factors are correlated; it means that they vary together. Positive correlation means that high scores on one are associated with high scores on the other, and that low scores on one are associated with low scores on the other. Negative correlation, on the other hand, means that high scores on the first thing are associated with low scores on the second. Negative correlation also means that low scores on the first are associated with high scores on the second. For negative correlation if value for one will increase then for the other it will decrease and vice-versa.

No.	Field	Cronbach's Alpha
1	Project Factors	0.769
2	Owner's Factors	0.741
3	Contractor's Factors	0.834
4	Consultant's Factors	0.800
5	Design Factors	0.770
6	Material Factors	0.818
7	Equipment Factor	0.758
8	Labour Factors	0.929
9	External Factors	0.867
	Total	0.973

Fig. 6 Chronbach's Alpha for each factor group of the questionnaire and the entire questionnaire

RESULTS OF QUESTIONNAIRE

The responses from the questionnaire were collected and were analyzed using Frequency Index F.I (%) and Severity Index S.I (%) for each factor of the nine categories / Groups of delays factors and then using F.I (%) and S.I (%) the Importance Index (%) was determined which is shown in Table 1. Based on this Importance Index (%) the delay factors are arranged in decreasing order of their importance or their capability to affect the performance of the project and delay it in terms of cost and time and for all these causes certain recommendations or mitigation measures for these delay factors were given.

FINDINGS AND CONCLUSION

The first step of reducing delays in Deep foundation construction project in vicinity of river or in areas with high water table is to understand their root causes / factors. A structured questionnaire survey approach was considers to study the impact of various

Correlations

			Original contract duration imposed too short	Late Hand over of Site from LOA	Ineffective Delay penalties	Legal disputes between various parts	Type of Project bidding and award negotiation lower bidder	Type of construction contract Turnkey construction only
Spearman's rho	Original contract duration imposed too short	Correlation Coefficient	1.000	.049	1.000**	.571**	.231	.049
		Sig. (2-tailed)	.	.776	.	.000	.175	.776
		N	36	36	36	36	36	36
	Late Hand over of Site from LOA	Correlation Coefficient	.049	1.000	.049	.117	.229	1.000**
		Sig. (2-tailed)	.776	.	.776	.498	.180	.
		N	36	36	36	36	36	36
	Ineffective Delay penalties	Correlation Coefficient	1.000**	.049	1.000	.571**	.231	.049
		Sig. (2-tailed)	.	.776	.	.000	.175	.776
		N	36	36	36	36	36	36
	Legal disputes between various parts	Correlation Coefficient	.571**	.117	.571**	1.000	.540**	.117
		Sig. (2-tailed)	.000	.498	.000	.	.001	.498
		N	36	36	36	36	36	36
	Type of Project bidding and award negotiation lower bidder	Correlation Coefficient	.231	.229	.231	.540**	1.000	.229
		Sig. (2-tailed)	.175	.180	.175	.001	.	.180
		N	36	36	36	36	36	36
	Type of construction contract Turnkey construction only	Correlation Coefficient	.049	1.000**	.049	.117	.229	1.000
		Sig. (2-tailed)	.776	.	.776	.498	.180	.
		N	36	36	36	36	36	36

**. Correlation is significant at the 0.01 level (2-tailed).

Fig. 7 Correlation test results for Project Group

attributes and factors affecting the above mentioned kind of infrastructure projects. The questionnaire assisted to study the perception of all the parties (i.e. contractor, sub-contractor, consultant, and client) involved. The results from this research, pin point the areas / factors which are critical for the performance of these kinds of projects and have the tendency to delay the project. Before implementation of any recommendation or any corrective measures fundamental principals should be followed so that significant improvements can be made. The following Departments and companies co-operated for collection of data for successful compilation and completion of this research paper: Supreme Infrastructure India Ltd, Freyssinet Menard India Pvt. Ltd, Sukriti Infrastructure Pvt. Ltd, Gammon India Ltd, Larsen & Toubro (L&T), HCC-Samsung, ITD-CEM, and also government offices like DMRC, CPWD, Delhi State PWD. With the help of this research the most critical causes or factors which have tendency of causing delay to Deep foundation Infrastructure projects near vicinity of rivers or in areas with high water-tables are listed below in tabular form in Table 2 arranged group wise and in decreasing order of their importance / severity.

GROUP	CAUSES	IMPORTANCE INDEX (%)	CRITICALITY
PROJECT GROUP	Type of Project bidding and award (negotiation, lower bidder)	30.34%	Critical
	Legal disputes between various parts	33.53%	Critical
	Original contract duration imposed too short	41.33%	Very Critical
OWNER GROUP	Slowness in decision making process by client	36.24%	Critical
	Delay in progress Payment by client	37.72%	Critical
	poor communication and coordination by owner and other parties	41.67%	Very Critical
	Late in revising and approving design documents by owner.	45.91%	Very Critical
CONTRACTOR GROUP	Poor qualification of the contractor's technical staff	36.82%	Critical
	Rework due to errors during construction	43.98%	Very Critical
	Difficulties in financing project by contractor	45.21%	Very Critical
	Ineffective planning and scheduling of project by contractor.	49.00%	Very Critical
	Poor site Management and supervision by the contractor	52.53%	Extremely Critical
CONSULTANT GROUP	Poor communication/ coordination between the consultant and other parties.	35.60%	Critical
	Conflicts between consultant and design engineer	39.10%	Critical
	Inadequate experience of consultant	41.33%	Very Critical
DESIGN GROUP	Insufficient data collection and survey before design.	46.14%	Very Critical

MATERIAL GROUP	Shortage of construction material in market	34.43%	Critical
	Shortage of material while they are needed urgently on construction site.	41.67%	Very Critical
EQUIPMENT GROUP	Lack of high technology mechanical equipment	35.88%	Critical
	Generator set / Power Failure	40.44%	Very Critical
	Low productivity and efficiency of the dewatering equipment	54.81%	Extremely Critical
	Failure of Dewatering Pumps	59.19%	Extremely Critical
LABOUR GROUP	Low Productivity level of labor	30.54%	Critical
EXTERNAL GROUP	Delay in providing urgent permissions	37.19%	Critical
	Different site(ground) conditions	42.90%	Very Critical
	Rain effect on construction activities	44.30%	Very Critical
	Inclement weather	44.30%	Very Critical
	Effects of subsurface conditions (e.g. Soil, High water table)	53.13%	Extremely Critical

Table 2 Results: Importance Index (I.I %) in decreasing order & degree of Criticality

RECOMMENDATION SUGGESTED

The following are the recommendation made for all parties in order to minimize and control delays in Deep Foundation infrastructure projects in vicinity of rivers of in areas having high water table:

6.3.1 Owner's should give special attention to the following factors:

- Pay progress payment to the contractor timely in order to impart contractor to main steady flow of cash for site working for maintaining smooth working conditions.
- To keep a check on changes during the commencement of projects.
- Avoiding delays in reviewing and approving of design documents than the anticipated time.
- To make a proper check for the resources and capabilities of the contractor, before awarding the contract. Rather than just awarding contract to lowest bidder.

6.3.2 Contractor's should consider the following factors

- Shortage and low productivity of labour should be improved by employing suffice amount of labour and improving their productivity by proper motivation either by cash or other rewards.
- Smooth cash flow should be maintained ensuring timely payment of all labour and sub-contractors. Contractor should manage his financial resources and plan cash flow by utilizing progress payment.
- The most important Factor for these kinds of project is controlling and monitoring ground water table. As, the project includes deep excavation therefore controlling of ground water is of foremost importance by using dewatering equipments.
- In order to achieve proper site management and supervision on any project it is important that administrative and technical staff should be assigned as soon as project is awarded to make arrangements to achieve completion within specified time with the required quality and estimated cost.

6.3.3 Consultant's should look to the following factors:

- Reviewing and approving design documents: Any delay caused by the consultant engineer in checking, reviewing and approving the design submittals prior to construction phase, could delay the progress of the work.
- Inflexibility: Consultants should be flexible in evaluating contractor works, Compromising between the cost and high quality should be considered.

6.3.4 Design Engineer should focus on the following factors

- Producing design documents on time: Design Engineer should set a schedule to complete design documents on time, otherwise it can result in delay in completion of work.
- Mistakes and discrepancies in design documents: They are common reasons for redoing and drawings and may take a long time to make necessary corrections.

RECOMMENDATIONS FOR FUTURE RESEARCH

It is recommended to develop performance measurement framework and modeling system in order to measure performance of construction organization and projects. In addition, it is recommended to study an devaluate the most important factors as a case study of construction projects in the area strip in vicinity of river or in area with high ground water table.

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