Changing Scenario for the Piling Industry in India

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ABSTRACT

As India marches ahead on the economic front, demand for speedier construction is gaining momentum. Abridged project durations which in the Indian scenario were beyond comprehension just a few years ago have already become the norm of the day. A better appreciation for the value of time and increasing cost of capital is posing newer challenges for the construction Industry. In order to take advantage of economy of scale, the size of the projects has increased significantly while the duration of the projects is shrinking. As civil engineers and particularly as geotechnical engineers, we routinely face situations posing fresh challenges. This changed scenario is necessitating a review of our construction and project management techniques, technologies and methodologies in order to keep pace with the fast changing demands of today’s projects. This paper presents a synopsis of the developmental plans as covered in the country’s 11th Five year Plan and presents a case history of a fast track piling project involving construction and sample testing of more than 8800 piles that were completed in less than four month’s time. The paper also discusses some of the commonly encountered hindrances in the execution of large, capital intensive projects.

1. DEVELOPMENTAL SCENARIO

According to CRIS INFAC Annual review report, Indian construction industry accounts for nearly 5% of Indian Gross Domestic Product (GDP) and is the second largest contributor, after agriculture. It is also second largest employer offering either direct or indirect employment to nearly 32 million. This sector is growing at the rate of 15% per annum. Physical Infrastructural activities pegged for the 11th Five Year Financial Plan (2007-2012) stand at a whopping figure of Rs. 23,132 billion (US $ 514.04 billion) which is considered essential to sustain overall growth of economy at over 9%. Developmental plans of such magnitude have several implications. The focus is therefore, shifting from traditional department based to private initiative based construction. This paradigm shift has induced new opportunities for introducing unique technologies, materials, fast track construction and maintenance strategies to reduce the cost.

The liberalization of our economy has brought home the urgency of recognizing that an efficient Industrial and Transport system is necessary for increasing productivity and enabling the country to compete effectively in the world market. The eleventh five year Plan (2007-2012) envisages very significant investments in the Infrastructure of the country. Of the amount of Rs. 23,132 billion ($514.04 billion), the share of the Central Government, the State Government and the Private Sector is projected at 37.16, 32.76 and 30.07 % respectively.

Table 1 presents estimated level of investment in key infrastructural sectors as per the 11th Five Year Plan and Table 2 reports a comparative infrastructural investment and planning for the 10th and 11th Five year plans.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Investment Requirements (in Rs. Crores)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modernization and up-gradation of highways and Bridges</td>
<td>314152</td>
</tr>
<tr>
<td>Irrigation (including water shed)</td>
<td>253301</td>
</tr>
<tr>
<td>Ports</td>
<td>87995</td>
</tr>
<tr>
<td>Railways (including MRTS)</td>
<td>261808</td>
</tr>
</tbody>
</table>

(Source: Planning Commission & Central Statistical Organization 11th Plan Period)
Table 2: Sector Wise Investment Plans for 10th and 11th Plans (Rs. Crore at 2006-07 price)

<table>
<thead>
<tr>
<th>Sector</th>
<th>10th Plan (Rs. Crores)</th>
<th>11th Plan (Rs. Crores)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>291850</td>
<td>666525</td>
</tr>
<tr>
<td>Roads and Bridges</td>
<td>144892</td>
<td>314152</td>
</tr>
<tr>
<td>Telecommunication</td>
<td>103365</td>
<td>258439</td>
</tr>
<tr>
<td>Railways (including MRTS)</td>
<td>119658</td>
<td>261808</td>
</tr>
<tr>
<td>Irrigation (including watershed)</td>
<td>111503</td>
<td>253301</td>
</tr>
<tr>
<td>Water supply and sanitation</td>
<td>64803</td>
<td>143730</td>
</tr>
<tr>
<td>Ports</td>
<td>14071</td>
<td>87995</td>
</tr>
<tr>
<td>Airports</td>
<td>6771</td>
<td>30968</td>
</tr>
<tr>
<td>Storage</td>
<td>4819</td>
<td>22378</td>
</tr>
<tr>
<td>Gas</td>
<td>9713</td>
<td>16855</td>
</tr>
<tr>
<td>Total (Rs. Crore)</td>
<td>871445</td>
<td>2056150</td>
</tr>
</tbody>
</table>

**Source:** Annual Plans and Planning Commission Documents and CSO.

This table indicates that construction segment constitutes a significant part of Infrastructural development in the economy. Even if Geotechnical engineering component is assumed at 10% of the total construction cost, the investment in this field by end of 11th plan is expected to be Rs. 205615 crores.

2. MEETING THE CHALLENGE

In order to meet this challenge, we need to critically review our entire approach to handling projects and make necessary amends to cut down on total project time. Fast track projects involve huge capital investments and therefore the necessity of streamlining the process and cutting down on wastage of time and therefore the cost takes prominence. The time from concept to completion must be reduced. The steps involved in a fast track project, typically relating to piling works, where the author feels improvements need to be made on priority can be listed as follows:

- **Organising Trained Manpower**

  Increasing infrastructural investments on a sustained basis in the last few years has put pressure on the availability of trained manpower. While the engineering colleges have realized the potential growth and have responded well to a large extent, the same thing cannot be said about the supervisory and workmen category. Unfortunately, in India, in the past we have mostly relied on on-the-job training of workmen and non-technical supervisory staff. We never had any concrete strategy for formal training in traits such as heavy machine operation, Piling / Diaphragm Wall rig operation, reinforcement cage making etc. hence it is going to be a real challenge to find trained manpower in the future in adequate numbers and it is high time that we develop a long term strategy to meet this challenge.

- **Financial Closure of Projects**

  Generally, the participants involved in the financial closure of a project lack direct experience of project execution hence they lack appreciation for the time required for procurement and construction. While considering the other aspects during planning stage, it will be desirable to ensure that an accelerated yet realistic time schedule is kept for the execution of the project. It is commonly seen that projects are not given sufficient time for execution resulting in unsafe and inappropriate construction practices, unnecessary pressure on the project execution team and more importantly overshooting of target dates of completion / commissioning.

- **Obtaining Statutory Permissions in Time**

  All requisite permissions including land acquisition and environmental clearances must be obtained prior to the construction phase. A number of large projects have been stalled midway or have become financially unviable due to hindrances cropping up at a later date causing unanticipated delays during execution. Such a waste of National resources must be avoided at all costs.

- **Overlapping of Design and Construction Phases**

  Traditionally, construction phase follows the design phase. After the design has been completed, tenders are floated which is followed by a negotiation and finalization phase and the construction commences thereafter. The tender documents are prepared by agencies hired by the owners and they fail to be fair and equitable to all concerned and the bidders are told to submit the bid without seeking any deviations else the bid is liable to be rejected.

  This approach does not allow us to make the best use of the experience available within the country. A more participative approach where the owners, the consultants and the execution agency come together and collectively develop the most advantageous scheme for the overall benefit of the project would certainly be more desirable. The present procedure of selection of execution agencies often results in conflicts later which are not in the best interest of the project.

  Typically, the time elapsed between the completion of design and start of construction is a minimum 3 months. We must try and save this time. For this, it will be best if the piling contractor is selected during the design phase itself so that he can contribute in the selection of pile type and completion of testing of initial test piles etc. during the design phase itself. Once the initial test piles are completed and incorporated in the finalized design, precious 8 to 12 weeks can be saved later.

- **Initial Testing of Piles**

  There is ambiguity regarding the requirement of minimum age of the pile before it can be tested. While the piling...
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The code stipulates 28 days, there appears to be no rationale for this other than ensuring that the concrete has attained the requisite 28 day strength prior to testing. If this is the only reason then one should be allowed to test the piles before 28 days also after ensuring that the 28 day strength is achieved on the sample cubes taken.

While the above argument sounds logical, there is however a minimum time required for the disturbed soils to stabilize. As one would imagine, cohesive soils would take longer to reach equilibrium as compared to granular soils. The present codes of practice as well as the project specifications are silent on this aspect and hence the interpretations differ with most consultants opting to adopt a safe 28 day criteria thereby losing valuable project time. There is therefore a clearly identified need to provide clarity on the subject.

Methods of Testing of Piles

Taller and heavier construction is posing a demand for higher capacity of piles. Need for optimization of design on the other hand entails more tests to provide comfort to all concerned. While integrity of the pile shaft can be checked quickly, the load carrying capacity of the piles along with its breakup of friction along the length and the end bearing is difficult to obtain. What this means is that a conservative but uniform design is utilized over a very large area of construction. What will be desirable is to incorporate in our codes and specifications the modern testing techniques such as High strain testing of piles, Statnamic testing and Osterberg Cell testing for very high loads.

Development of Site

It is this author’s experience that on a number of projects, piling work is commenced without development of the site. Under the circumstances, the piling contractor is expected to make temporary roads and approaches, develop areas for their office, stores, batching plant etc. While somebody may be tempted to think that this will result in cost saving on the project, the reality is quite to the contrary.

If a piling agency does tasks which are beyond their area of expertise, they build this cost in their rates along with margins on this subcontracted work hence there is really no saving to the project. More importantly, this delays the start of piling and/or reduces the efficiency of the piling operations which a fast track project can ill afford. It is therefore recommended that the owner takes up site grading, access road construction, drain construction work prior to the award of piling work.

Updation of the IS Code

The present revision of the IS Code on piling is outdated and there is an urgent need to revise it and bring it in line with the present technological advances and knowhow. Some of the critical issues which need immediate review are as follows:

- Insistence on use of only modified Hiley’s formula for Driven Piles. The code should allow other alternatives for determination of dynamic capacity.

- Allowable settlements in piles. A more practical approach to acceptance criteria for pile load tests since the current criteria is considered conservative.

- Allowance for use of Blended cements and additives

- Lateral load capacity for piles and its determination for layered soil stratum

- Considerations for load tests under deep cut-offs (more than 6 metre deep)

- Use of polymers in place on Bentonite slurry

- Guidelines on air flushing

- Guideline on the type of Rotary rigs that can be used for piling

- Incorporation of other types of piles such as Auger Cast Piles, Spun Concrete Piles etc.

While this is awaited, it is recommended that the project team does not close out the option of using standard codes of practice from other countries to accommodate use of newer technologies on their projects as precluding their use would be against the interest of any project.

2. EXECUTION OF A FAST TRACK PROJECT – A CASE STUDY

A crude oil storage facility was planned in a remote port town along the coast of Gujarat. The facility comprised of 22 tanks supported on driven, cast in situ piles of 560 mm diameter. The safe capacity of the pile was 110 tons and the expected length of the piles was 15 metres. A generalized subsoil profile encountered at site is reported in Figure 1 below.

Fig. 1: Representative Sub-Surface Profile at the Piling Site
The scope of the project for the piling contractor included the following:

- Sand filling: 43,491 m$^3$
- Earth filling: 77,596 m$^3$
- RCC driven, cast in situ piles: 8,809 no.
- Reinforcement for piles: 4,800 T
- Initial and routine load tests:
  1. Vertical load tests: 37 no.
  2. Lateral load tests: 36 no.
  3. Pull out load tests: 14 no.
- Low strain integrity tests: 850 no.

The total time duration available to the contractor was only 6 months including time for mobilization and initial pile load tests. The working piles could not be started unless a few initial tests were completed leaving just about 4-1/2 months to complete 8,809 piles along with testing. The challenge was indomitable and required a total rethink on all aspects on part of all partners of the execution team to make it a success.

The owners, the designers and project management consultants and the piling contractor came together and decided that decision making in all respects will be expedited and accorded top priority with the target being ‘zero production time loss’ in the field. The piling contractor mobilized the first two rigs and a mobile batching plant within 2 weeks time. The earthwork was commenced simultaneously and areas to accommodate rigs were readied sequentially. Daily, weekly and monthly monitoring of targets was resorted to.

A full fledged mechanical team along with full inventory of fast moving spares was maintained at site. Adequate lighting and workforce was made available for ensuring round the clock working. Appreciating the fact that even a decent workshop facility was at least 120 km away, it was decided to mobilize even some of the plants on standby.

Just prior to the commencement of this project, R&D team of the Piling Contractor had successfully completed the task of development of a 100% indigenous pneumatic hammer of 5.4 T Ram weight which could be used with a crawler crane for ease of mobility. This hammer could not only yield 36 to 38 blows per minute as against 15 to 18 blows with the conventional Driven Piling Rigs but also had a big advantage in terms of reducing the transit time in between piles. While the conventional rigs used winch arrangement to pull and slide over wooden logs, the hammer mounted on Crawler cranes could move much faster. This technical advantage proved to be a key factor in achieving higher productivity rates on this project. Photographic plates 1 and 2 show the hammer and the crane mounted rig in operation at the site.

After satisfactorily completing the Initial test piles in 25 days, the working piles commenced on the 47th day with the help of 3 rigs initially. Details of other major plant mobilized are contained in Table 3.

### Table 3: Major Plant Mobilised to Site

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Plant Description</th>
<th>No. Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ITD Pneumatic Driven Pile Rigs</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>75 T Crawler Crane</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>Batching Plant</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Transit Mixer</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>Lighting DG</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>Air Compressor 1100 CFM</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Crawler Crane 330</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>JCB, Hydra, Loader, Tractors</td>
<td>As Required</td>
</tr>
</tbody>
</table>

The cycle time for the initial piles ranged from 1.0 to 1.5 hours per pile. The project team studied this aspect and made a number of improvements which streamlined the operations further. The streamlined operations resulted in unprecedented reduction in unit piling time and resulted in completion of targeted piles well ahead of schedule. Some of the achievements are listed in Table 4.

### Table 4: Achievements of the Project

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Piles Installed in one day</td>
<td>211 nos.</td>
</tr>
<tr>
<td>Maximum Piles installed by a single rig in one day</td>
<td>40 nos.</td>
</tr>
<tr>
<td>More than 100 Piles installed in a day</td>
<td>44 times</td>
</tr>
<tr>
<td>Maximum piles in a week</td>
<td>1,042 nos.</td>
</tr>
<tr>
<td>Maximum piles installed in one month</td>
<td>3,301 nos.</td>
</tr>
<tr>
<td>Maximum meterage of installed piles in one month</td>
<td>48,360 m</td>
</tr>
</tbody>
</table>

The entire scope of 8,809 piles, along with associated initial and routine testing was successfully completed in 179 days. Such unprecedented achievement was possible primarily because of the following reasons:

- Total understanding and cooperation between all the parties involved in the execution of the project.
- Requisite permissions and preliminary site developmental activities completed prior to construction phase.
- Advanced technology developed and used successfully for pile driving, thereby cutting down drastically on the cycle time per pile.
• Excellent Project planning and monitoring ensuring minimum loss of productive time.

3. CONCLUDING REMARKS

The preceding sections provided an overview of key sectors in the Indian infrastructure development along with an appeal to the civil engineers to make a self assessment and initiate pro-active changes. To cater for the massive developments in transportation and infrastructural sectors, latest technologies, resources and skills need to be utilized in deep foundation construction as well. Case study of fast track piling works carried out at Mundra (Gujarat) clearly demonstrates that proper project planning, monitoring and technological advancements can certainly lead to safe, efficient and progressive work environment. Further, the growth requirement as planned by the Government points to an urgent need for changing our mindsets in order to meet challenges in the construction of deep foundation systems to keep abreast with the desired sustainable growth.

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