



Multi-storied building formwork techniques scenario in Surat

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ABSTRACT:

Formwork systems can play a vital role in the success of a construction project in terms of time, quality construction and economy. Clients demand their project to be completed as early as possible and at a minimum cost. For a multi-storied building, the most efficient way to speed up the work is to complete RCC framework for typical floors of the structure in the shortest possible time. Authors conducted a questionnaire-based survey in Surat city. The study aimed to understand the intervention that prevails for not implementing the aluminium formwork technique in place of the conventional ones. The most used formwork system in the city for high-rise residential construction was a combination of timber & steel with 37.60% usage while the least used was aluminium formwork with merely a 2.7% of usage.

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Keywords:

Aluminium Formwork system, Cost-effective, Multi-storied and Real Estate.

1. Introduction

According to the survey conducted by the United Nations, the Construction Industry in India is experiencing a new dawn with breakthrough research in the field of construction techniques and equipment. Formwork system which is used to support and hold the fresh concrete until it is hardened subsequently is a crucial part of the building process. Existing scenario is demanding for a faster completion of multi-storied buildings. The reasons could be the entry of multinational organisations in the construction industry and provisions through ambitious 'Make in India' campaign recently launched by the Government of India. Around 27.5% of the total material is wasted because of the quality of the formwork [2]. Such losses affect directly or indirectly to the GDP of India. The construction of formwork requires time and consumes 20 to 23% of the total cost of the project or even more. Due to the use of inferior formwork in the Reinforced Cement Concrete (RCC) construction, the accidents also increase manifold [2]. Formwork system affects the cost, time, and quality of project delivery. However, still innovative formwork systems are not practised much in India, and most of the contractors are hesitant to the current technology as they are dubious of facing failure in the project, and also as they are much habitual with the extant formwork type, the traditional type. Espousing the excellent formwork technique for each project will lead to sustainable construction. The problems of inferior construction, corrosion of structures, time and cost over-runs, poor finishes leakages, and such can be dodged by utilising modern formwork systems as aluminium formwork and tunnel formwork. It can also help avoiding repairs and rehabilitation of structures before its expected life span. This paper discusses rarely used aluminium formwork in Surat city of Gujarat, India. Aluminium Formwork has merits over the conventional formwork systems such as timber formwork and steel formwork. It covers the limitations of both of them making it the superior amongst the three of it. To explore the conceptual thought, the authors, in the absence of direct experience, decided to prepare a questionnaire. The technical staff engaged in real estate were the respondent. The comparisons include costs, time, and quality of these systems.

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2. Motivation

Over the time, the authors were observing the construction of the high-rise buildings in Surat city. It was constructed using conventional formworks (Steel, Timber and Plywood) resulting in more time consumption. Aluminium has many merits to the timber and steel as a material and formwork system. So, the authors decided to look deeper into the matter and investigate the possible reasons thereof.

3. Aluminium Formwork

Formwork systems are amidst the major factors which determine the accomplishment of a construction project on speed, quality, cost and safety of the works [4]. The rapid advancement in the field of formwork along with the innovation in concrete as a material has led to a pioneering change where quicker, safer, sustainable and more efficient construction is possible. The aluminium forms are almost missing in the new scenario of the Indian construction industry. The aluminium formwork system contributes in saving cost, time and enhance the quality of construction. Aluminium Formwork is well used in South East Asia [9] and the Middle East for the construction of residential units, both single and multi-storied buildings. The aluminium formwork system is proven to be very cost effective where it is practiced [6]. It is one of the systems identified to be most suited for Indian conditions of mass housing [3]. Using the system, the quality and high-speed for construction can be achieved [7]. The labour can handle the method effectively to accelerate the construction, to assure quality control and durability [5]. Below is a comparison of characteristics between Aluminium Formwork System and Conventional Formwork System.

Table 1 Comparison between Aluminium Formwork System and Conventional Formwork System [1]

Characteristics	Aluminium Formwork System	Conventional Formwork System
Speed of construction	Four days' cycle per floor.	Min. cycle time is 21 days.
Quality of surface finish	Excellent. Plastering is not required	Bad. Plastering is required
Pre-planning of formwork system	Required	Not required
Type of construction	Cast-in-situ Cellular construction	Simple RCC framed construction
Wastage of formwork material	Very less	In great amount.
Accuracy in construction	Accurate construction	Accuracy is Less than Modern Systems
Coordination among agencies	Essential	Not necessarily required
Resistance to earthquake	Excellent resistance	Less than Modern Systems
Removing of floor slab forms without removing props	Possible	Not possible
Need of any timber or plywood	Not required	These are the main components
Re-usage value of formwork	250 – 300	Maximum 50
Suitability for high rise construction	Very much suitable	Not suitable

Initial investment in the system	High	Less
Economy in construction	Economical for mass housing	Economical on small scale

4. Study Area

Surat city of Gujarat is well-known for its economic contributions. Major stake to economy is through the diamond polishing and jewellery manufacturing, and textile trading. It contributes to significant wealth generation of the society, and the subsequent effect is transferred to real estate sector in the region. The city is located 284 kilometres South of the state capital, Gandhinagar. It is situated at latitude 21°15'N and longitude 72°52'E. It consists of a population of more than 4.5 million as per the 2011 census, making it the second prime city in the state of Gujarat, post-Ahmedabad. It is the eighth large town and ninth most populous urban agglomeration in India. Surat globally ranks 34th in the greatest city by area and 4th-fastest evolving cities in a study organised by the City Mayors Foundation, a universal think tank on urban interest [10]. The city houses 1.5 million tenements over a geographical area of about 326 sq. km. The construction activity is moderated by the Surat Municipal Corporation (S.M.C.) under the provisions made by Surat Urban Development Authority (SUDA). It operates the GDCR enforced through Twelfth Schedule under Article 243W of the 74th CAA, 1992 [8].

5. Methodology

The first step of the survey was to identify the need for the survey and formulation of synopsis followed by the finalisation of research intervention. Related research data was collected and analysed, and the detailed study was performed. In the present work, the data related to conventional formwork system have been collected and analyzed. From these data, following details related to conventional formwork system have been analyzed through a scientifically formulated questionnaire.

- Name of the respondent;
- Highest qualification of respondent;
- Present occupation of respondent;
- Experience of respondent;
- Awareness about aluminium formwork;
- Common types of formwork used in their construction project;
- Erection time various popular formwork takes;
- Strength and durability of various formwork;
- Most economic formwork;
- Factors that contribute to the problem/defects of formwork;
- Different criteria are seen while selecting formwork;
- Formwork cost contribution in the entire project;
- Volume of concrete used; and
- Details regarding whether they employ skilled labours, competent formwork engineer and formwork specialist.

After gathering the information from 226 respondents engaged in various activities of civil engineering, the authors performed statistical analysis using computational tools.

6. Analysis & Results

Out of the 226 respondents questioned, about 53.53% completed diploma, 39.38% completed B.E. Civil, 6.20% completed M.E. Civil, and only 0.88% have Ph. D. by educational qualification.

Out of 53.53% diploma holders, about 44.23% are working as site engineers, and 6.19% are engaged in government jobs. For graduate Civil engineers, the distribution is not only in the sector of construction of the

building. From 39.38% of these graduates about 23.89% are working as site engineers and about 13.71% are government servants. In the case of planning/designing consultancy jobs, M.E. Civil and Ph.D. candidates are majorly involved. It is evident from Fig. 1, that the civil engineers show career inclination towards private jobs rather than government jobs.

By qualification, it was found that individuals who had completed B.E. Civil were aware of aluminium formwork system compared to those with a diploma. While in the case of M.E. Civil and Ph. D., all were conscious of the aluminium formwork system.

From the graph below of the relation between highest qualification and present occupation of the respondent, we can infer that the larger part of the individuals holding a Diploma in Civil Engineering and graduates prefer the construction of buildings. However, post-graduates often are involved in the planning and designing/consulting jobs instead.

23.88% of 53.53% diploma holders have an experience of 0 to 5 years, while about 14.15% of 39.38% graduates have such an experience. Hence, 41.15% respondents have an experience of 0 to 5 years while 23.89% have an experience of 5 to 10 years.

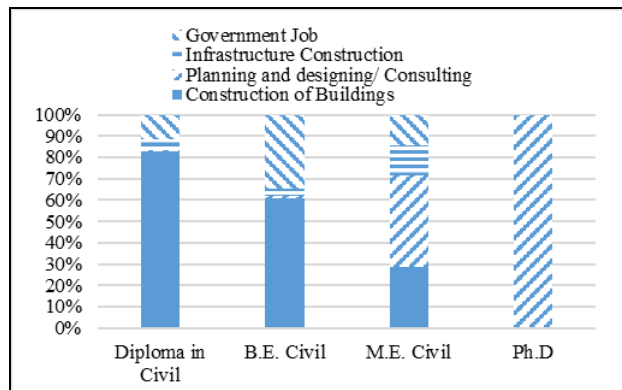


Figure 1 Highest Qualification vs. Occupation

Above chart shows that 53.09% were aware of the aluminium formwork while 46.91% were not. Among the 20.79% responses by the government employees, 15.92% were aware of the aluminium formwork. While in the case of engineers working in private firms, only 30.08% were aware of aluminium formwork out of the 69.91%.

Thus, it can be concluded that engineers working for the government are more aware of the aluminium formwork system compared to private firms. Also in the case of planning/consulting, almost everyone knew about the aluminium formwork system. As the experience increase, it can be seen that out of 22.56% having an experience of 10 to 20+ years about 19.91% were aware of aluminium formwork system. Thus it can be concluded that people having an experience of fewer than ten years are unaware of aluminium formwork system.

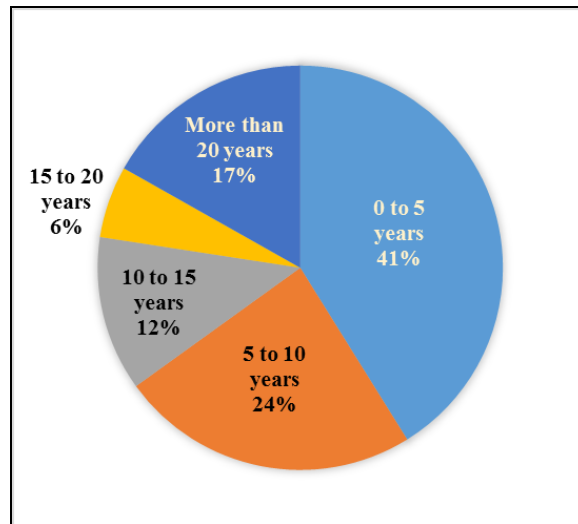


Figure 2 Experience of respondent

The percent of cases gives the percentage of the amount a formwork is used on an average.

Table 2 Various formwork systems used in Surat city

Common Formwork used by Respondents	Numeric Responses	Percent	Percent of Cases
Timber Only	71	15.80%	31.40%
Plywood Only	53	11.80%	23.50%
Steel Only	53	11.80%	23.50%
<u>Aluminium</u>	<u>6</u>	<u>1.30%</u>	<u>2.70%</u>
Timber + Plywood	58	12.90%	25.70%
Steel + Plywood	70	15.60%	31.00%
<u>Timber + Steel</u>	<u>85</u>	<u>18.90%</u>	<u>37.60%</u>
Timber + Steel + Plywood	54	12.00%	23.90%
Total	450	100.00%	

Table 2 various formwork systems used in Surat city reveals that the most traditional formwork in Surat is Timber & Steel followed by timber and then Steel & Plywood.

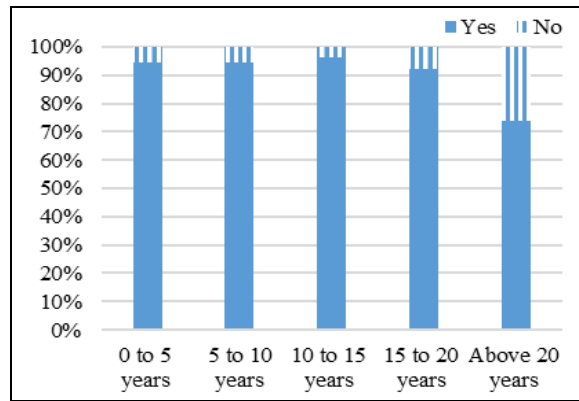


Figure 3 Preference for skilled labours

About 91.15% engineers believe in employing skilled workers. It is evident from the above graph above that the responding engineers despite their experience, commonly believe that the skilled labours must be hired for on-site works. About 71.68% people employ more skilled workers compared to unskilled workers.

About 57.08% believes in appointing a competent formwork engineer to carry out the tasks. When technicians were not employing specialised formwork agencies, they appointed a competent formwork engineer. However, from Fig. 4 and 5, one can understand that the trend of specialized agencies is decreasing, and the necessity of competent engineers is increasing.

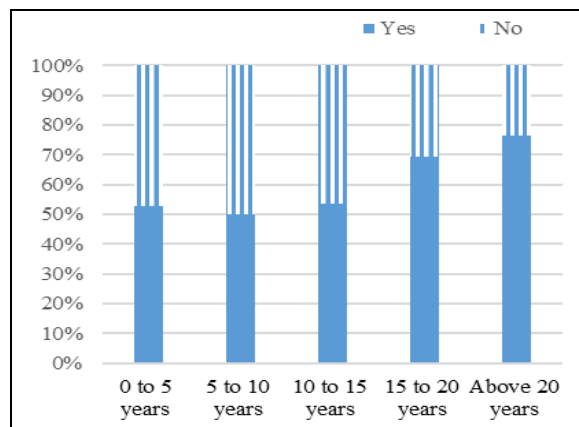


Figure 4 Preference for Competent Engineer

From the below graph, it is seen that the current graduates prefer not to employ a specialized agency for the formwork. About only 29.64% engineers believe in engaging a formwork specialist for their projects.

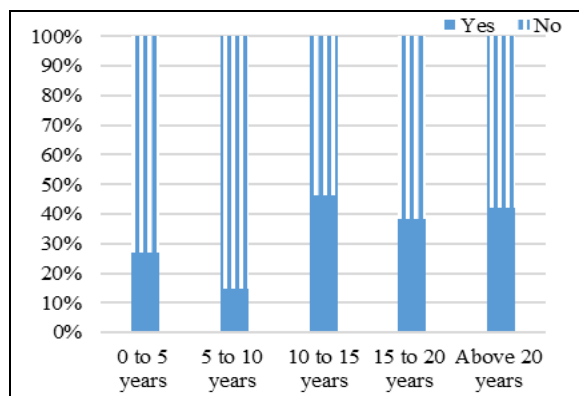


Figure 5 Preference to appoint specialised agency

From the analysis, authors identified that engineers with an experience between 15 to 20+ years, 58.82% considered employing skilled labour more than the unskilled. Engineers with an experience of 0 to 15 years,

75.42% believed in employing more of skilled labour than the unskilled. Thus people having experience of 0 to 15 years think skilled labours are more important for the formwork.

The survey also revealed that amongst individuals who employed formwork agency about 70.35% did not believe in appointing a competent formwork engineer. Thus it can be seen that people are more dependent on formwork specialist sub-contractors and not the individual experts.

Authors identified that the formwork cost contribution to the total project, stands around 20% to 23% depending upon complexity involved. The research results state that the volume of concrete used in the multi-storied building has a volume of about 1,900 Cu Mt to 2,000 Cu Mt. It was also responded that the steel formwork system is more time consuming in the erection-dismantling process compared to timber and plywood formwork systems. However, the engineers believe (91.15%) that the steel formwork system comparatively is more durable and allow more of repetitive use. It is also believed (by 50.88% engineers) that the steel formwork system is the most conservative one.

As far the problems are considered, 77.87% respondents believe that the poor communication between the engineers and labours is a driving factor. Also, 87.61% agrees to the poor supervision as a governing aspect contributing problems in formwork. Given 86.28% respondents, poor workmanship is a primary reason. Nevertheless, 71.23% believes that the poor planning of tasks is among driving force for defects in the formwork. In all, the poor supervision and poor workmanship are thought to need utmost care.

Respondents prioritise the selection of form type for a project by the quality of work (by 92.47%), cost consideration (86.42%), environmental concerns (60.62%) along with design and risk considerations (68.14%).

Conclusion

From Fig. 3 and 4, authors deduce that the young brigade of civil engineers relies more on skilled labours and less on competent engineers. It further explains that hiring of experienced labours with expertise in conventional methods is popular against availing benefits of modern formwork systems. The poor level of awareness among the youth for advanced practices such as aluminium formwork is well reflected in Fig. 5. As a result, the prevailing scenario of real estate sector can undergo a paradigm shift in construction method.

Focus on a detailed investigation considering principles of construction and project management can lead the future efforts. The cost, reusable life, safety and reliability, transportation and storage of components may be explored in detail. A comparative analysis for similar yet specific multi-storied buildings will reveal more specific and deterministically helpful results. Such an effort will contribute to upgrade the prevailing real estate practices in the region.

Acknowledgements

Authors are grateful to Mivan technology for innovating aluminium formwork system so that they could carry out this research. Gratitude is due towards Dr Vaishali Mungurwadi, Principal, SCET and Prof. Dharmesh Bhagat, Head-Civil Engineering Department for their consistent support in the research endeavours. Support of respondents representing Surat city's Real Estate sector is very much appreciated.

References

- [1] Chotaliya, J., & Rathod, H. (n.d.). Comparison of the use of Aluminum and Conventional formwork systems. *International Journal of Advanced Research in Engineering, Science & Management*.
- [2] Kumathekar, M. B., & Karke, S. M. (n.d.). *Comparison of the use of Traditional*. Civil Engineering Systems and Sustainable Innovations. Retrieved July 4, 2016

International Conference on Futuristic Trends in Engineering, Science, Pharmacy and Management

- [3] Parekh, N. M., Marwadi, B. M., & Patel, U. (n.d.). Comparative studies of construction techniques. *Journal of Information, Knowledge and Research in Civil Engineering*.
- [4] Patil, D. S., & Desai, D. B. (n.d.). Emerging Trends in Formwork - Cost Analysis & Effectiveness of Mivan Formwork over the Conventional Formwork. *Journal of Mechanical and Civil Engineering*, 27-30.
- [5] Pitroda, D. J. (2015). Recent scenario in formwork: Aluminum. *Engineering: Issues, Opportunities and Challenges for Development* (p. 7). Umrah, Bardoli (Surat): International Journal of Advanced Research in Engineering, Science & Management (IJARESM). Retrieved July 4, 2016
- [6] Vatsa, I., Dewangan, A., & Gupta, D. P. (2015). The significance of Mivan technology. *Bulletin of Advanced Scientific Research*.
- [7] Shah, K. (2015). Modular formwork for faster, economical and quality Construction. *Indian*, 6-23.
- [8] Government of India, L. M. (2016, July 22). *The Constitution (Seventy-Fourth Amendment) Act, 1992*. Retrieved from India Code Legislative Department: <http://indiacode.nic.in/coiweb/amend/amend74.htm>
- [9] Mivan Contractors. (2016, 5 15). *Mivan Excellence and Innovation*. Retrieved from Mivan: <http://www.mivan.com>
- [10] *Wikipedia*. (2016, 1 4). Retrieved 7 4, 2016, from Wikipedia: <https://en.wikipedia.org/wiki/Surat>