

“Study of Modern Formwork System for Fast Track Construction”

Ms. Shivani R. Barve¹, Prof. R. S. Ingalkar², Prof. S. Sabihuddin³

PG Student, Construction Engineering & Management, Civil Engineering, PRMCEAM- Badnera, Amravati, India¹

Assistant Professor, Civil Engineering, PRMCEAM- Badnera, Amravati, India²

Associate Professor, Civil Engineering, PRMCEAM- Badnera, Amravati, India³

Abstract: In our present world construction industries are the main ingredient for the development. So due to the rapid growth in construction industry, it is not possible to manage the project through conventional ways. Construction industry is having biggest role in economy of India. In recent times, if we look at the global economy and growth of population in India, land acquisition has become more difficult. To fulfill the need of shelter of this growing population and increasing industrialization, speedy construction is the necessity of time. Same time, due to inadequacy of land Vertical growth is preferable than Horizontal one. The high rise building construction consists of number of repetitive activities and also have same identical floors. The increase in duration of construction greatly affect the construction cost. Selection of best formwork system gives best result in cost saving. So that advanced formwork system helps in cost saving as reduction in slab cycle time. Conventional construction methods are not able to cope with the demand of infrastructural facilities with high degree of quality control & assurance. No doubt, conventional methods prove to be economical, but they fail in providing required number of dwellings in time; hence latest construction technologies by applying fast-track construction is the only remedy left to address this issue. The quality of construction mostly depends on the formwork used. This study aims to discuss and evaluate the various formwork systems available, and to show their impact on project duration, cost, quality, cycle-time, number of repetitions, labour requirements. Through literature review, data about various formwork systems available are collected. The current practices in Amravati region are known from various stakeholders through a questionnaire survey and case studies. Data analysis will be done using the data collected from the literature review and the questionnaire survey. The data were analyzed using Relative Importance Index (RII). Ranking of factors were done on the basis of RII and ranking them as per their degree of importance using Relative importance index method. The top 5 factors responsible for adopting the modern formwork system in construction projects, are High initial cost, Advanced Training Session, Lack of awareness, Suitability for mass housing project, Design flexibility.

Keywords: Fast Track Construction, Formwork, Conventional, Mivan, Tunnel, Aluform, Time, High Rise Building.

I. INTRODUCTION

Formwork is defined as temporary structure whose purpose is to provide support and containment for fresh concrete until it can support itself. It moulds the concrete to the desired shape and size and controls its position and alignment. As the topic fast track construction is very vast, the scope of study is limited as far as this project is concerned. The scope of study of this is limited to certain areas in fast track construction techniques, as form work systems. Formwork which is the basic element in any construction project is one of the aspects where new techniques can be implemented for cost cutting in long run. The formwork system plays a vital role in construction, and choosing the right formwork system can result in sustainable construction. The cost of formworks is much higher than we consider it in project cost; it is around 20-25% of the project cost. Formwork is used to provide temporary support for the concrete until it can stand on its own. This confirms that, the various types of formwork used in construction, which varies according to the type & needs of the project. Concrete is poured into formworks, which are commonly made of steel, wood, aluminium, prefabricated forms, etc. The key considerations influencing the choice of formwork for high-rise buildings are time, cost, and quality. As traditional formwork systems are being replaced by advanced ones, the need for the newly emerging type of formwork systems is increasing. These formwork systems must be strong enough to support loads, retain shape, and be free of leaks, and the material used for formwork must be inexpensive, readily available, and reusable. The advancement of technology, increase of population and the space limitation lead the way to construct high-rise buildings. By conventional method we required more time to complete the project.

The first formwork type to be used is the conventional type formwork where the timber planks were supported on timber columns. With the advancement of technology it developed gradually and people used ply wood sheets instead of timber planks and steel pipes with jacks were used to support the ply wood. Then people invented small units of

formworks and connect the repeating units in the construction. The larger units were invented like formworks for slab panels, formworks for columns, beams etc. when the same elements are repeating. Then finally the whole system of formwork is made and initially the material used to it was steel and it was very heavy. Then the aim was to reduce the weight of the system and the materials for formwork have extended to aluminium, plastic, fiber glass etc. Aluminium formwork system provides aluminium formwork for RCC load bearing or RCC framed multi-storied buildings and enables the walls and slabs to be poured in same operation. These increases efficiency and also produces an extraordinarily strong structure with excellent concrete finish.

II. RESEARCH METHODOLOGY

A. Research Process

This study adopted case study research methodology in order to do an in-depth inquiry regarding most effective formwork system for high rise building construction. For data collection questionnaires was prepared on the basis of objectives of the project. Questionnaire survey was collected from different sites of Amravati region and few are done using google form survey. For case study of conventional formwork two sites were taken, first is “Sumeru Shankara” is using plywood formwork System and second is “Skyblue”. For the study of tunnel and aluminium formwork system previous research paper works were studied. During collecting data, the factors considered during the selection of formwork for any project from various stakeholders was collected. Both primary and secondary data were collected. The primary data was collected by observation & questionnaire survey. The secondary data was gathered by reviewing literature from related research works and other sources.

B. Relative Importance Index (RII) Technique:

The Relative Importance Index method is used to determine the relative importance of various factors. The goal of such analysis is to explained variance among multiple predictors to better understand the role played by each predictor. The five point scale ranged from 1 (Strongly Disagree) to 5 (Strongly Agree) were adopted and transformed to relative importance indices. The RII was used to rank the different factors. The ranking made it possible to compare the relative importance of the major factors and minor factors amongst each factors perceived by the respondents. Relative Importance Index (RII) analysis was employed to measure the Likert importance scale. In this study, five scale rating was used and the weight was give as below:

1-Strongly Disagree; 2 – Disagree; 3-Neutral; 4-Agree; 5-Strongly Agree

The RII was calculated by using the formula as below:

$$\text{RII} = \frac{\sum W}{A * N}$$

Where,

W = Weight of scale;

A = Highest weight ('5' in this case);

N = Total number of respondent

III. RESULT & DISCUSSION

This study involves a questionnaire survey approach from which data was collected to answer questions in respect of the main subject of study. Questionnaire is the main tool used. The responses received from local construction professionals and students. The questionnaire survey was carried out by meeting various stakeholders. From few responses, some responses were taken from various students. A google form survey was conducted to know about their awareness of different kinds of formwork systems in India and the factors influencing the selection of formwork systems.

The computed RIIs and their respective ranks as perceived by respondents are summarized in Table 1.0. Most important factors according to the perception which are considered during the selection of formwork for any project are Cost, Quality, Safety, Labour availability, Cycle time, No. of repetitions, Hoisting techniques. According to the respondents, it seems that Cost is the most important factor as it has the first rank among all factors with relative index (RII) equal to 1. Quality has been ranked in second position by the respondents with RII equal to 0.940. Safety issue has been ranked in third position with RII equal to 0.832. Labour availability has been ranked in fourth place with RII equal to 0.660. Cycle time has been ranked in fifth place with RII of 0.556. No. of repetitions and Hoisting technique has been ranked in sixth and seventh position with RII equal to 0.428 and 0.288 respectively.



Table 1: RII & Ranking of factors that consider during selection of formwork

Factors	Response					Total (N)	ΣW	RII	Rank
	1	2	3	4	5				
Cost	0	0	0	0	50	50	250	1.000	1
Cycle time	0	23	15	12	0	50	139	0.556	5
Quality	0	0	0	15	35	50	235	0.940	2
No. of repetitions	26	0	15	9	0	50	107	0.428	6
Safety	0	0	10	22	18	50	208	0.832	3
Labour availability	0	0	35	15	0	50	165	0.660	4
Hoisting technique	28	22	0	0	0	50	72	0.288	7

Figure 2 gives graphical representation of relative importance index of factors considering during selection of formwork. The graph plotted between various factors and RII of respective factors.

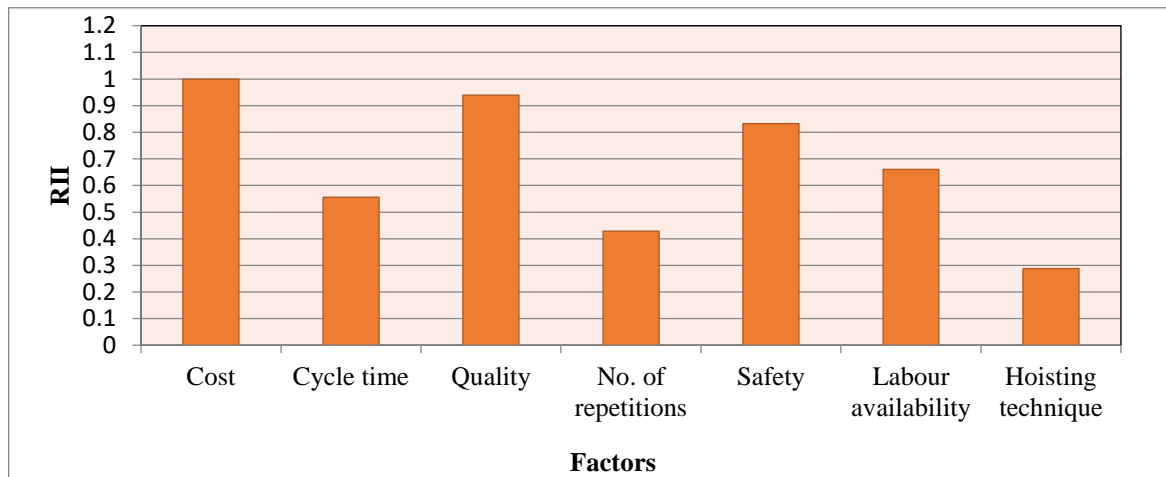


Figure 1: RII of factors considered during selection of formwork

Figure 2 illustrates percentage of responses given to the factors considered during selection of formwork by respondents. For cost about 100% of responses are obtained for weightage 5 and 0 % responses are obtained for weightage 4, weightage 3, weightage 2 and weightage 1 respectively. For cycle time about 24 % responses are obtained for weightage 4, 30% responses are obtained for weightage 3, 46% responses are obtained for weightage 2 , 0% responses are obtained for weightage 5 and weightage 1. For quality 70% responses are obtained for weightage 5, 30% responses are obtained for weightage 4, 0% responses are obtained for weightage 3, weightage 2 and weightage 1. For no. of repetitions 18% responses are obtained for weightage 4, 30% responses are obtained for weightage 3, 52% responses are obtained for weightage 1, 0% responses are obtained for weightage 5 and 2. To safety 36% responses are obtained for weightage 5, 44% responses are obtained for weightage 4, 20% responses are obtained for weightage 3, 0% responses are obtained for weightage 2 and weightage 1. To availability of labours 30% responses are obtained for weightage 4, 70% responses are obtained for weightage 3, 0% responses are obtained for weightage 5, weightage 1 and 2. To hoisting techniques 44% responses are obtained for weightage 2, 56% responses are obtained for weightage 1, 0% responses are obtained for weightage 5, weightage 4 and 3 respectively.

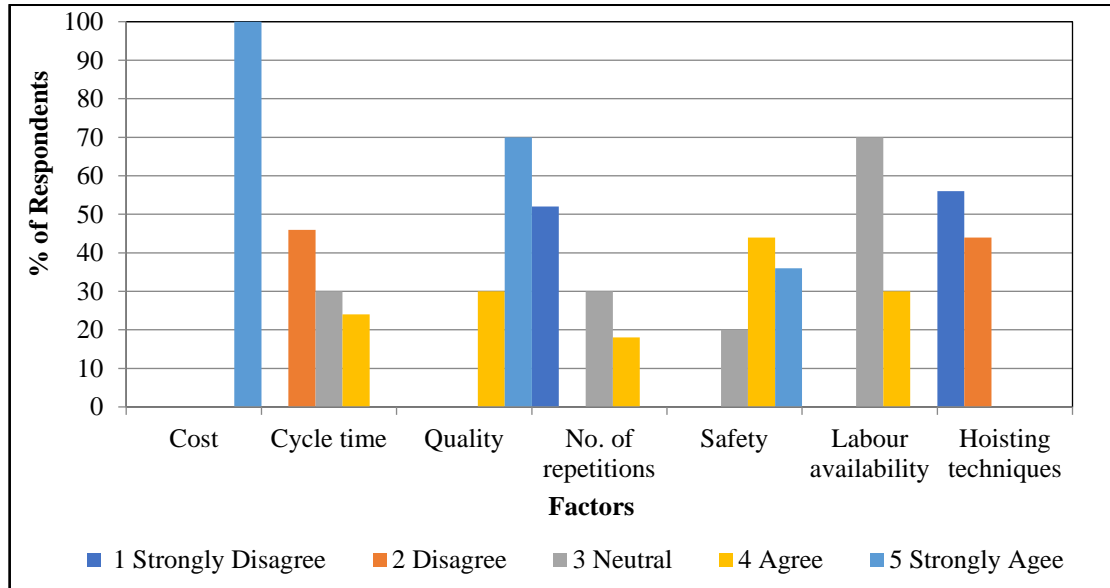


Figure 2 : Percentage Response rating of factors considered during selection of formwork

The computed RII and their respective ranks as perceived by respondents for factors responsible for adopting modern formwork system in any project are summarized in Table 2. From Table 2 most important factors according to the perception are high initial investment, lack of awareness, design flexibility, additional machinery requirement, need of advanced training sessions, need of skilled labours. According to the respondents, it seems that high initial investment is the key factor which is responsible for adopting modern system as it has the first rank among all with relative index (RII) equal to 0.952 .Need of advanced training sessions has been ranked in second position by the respondents with RII equal to 0.856.Lack of awareness a overall issue has been ranked in third position with RII equal to 0.732.Suitability for mass housing projects has been ranked in fourth place with RII equal to 0.656.Design flexibility, resistance to change, additional machinery requirement, co-ordination between different agencies, need of skilled labours has been ranked on fifth, sixth, seventh, eighth & ninth with RII equal to 0.588, 0.488,0.336, 0.272, 0.244 respectively.

Table 2: RII & Ranking of factors responsible for adopting modern formwork system

Factors	Response					Total (N)	ΣW	RII	Rank
	1	2	3	4	5				
High initial investment	0	0	0	12	38	50	238	0.952	1
Lack of awareness	0	0	22	23	5	50	183	0.732	3
Design flexibility	0	0	42	8	0	50	158	0.632	5
Additional machinery requirement	26	14	10	0	0	50	84	0.336	7
Need of advanced training sessions	0	0	0	36	14	50	214	0.856	2
Need of skilled labours	42	5	3	0	0	50	61	0.244	9
Co-ordination between different agencies	32	8	10	0	0	50	78	0.312	8
Suitability for mass housing projects	0	0	36	14	0	50	164	0.656	4
Resistance to change	0	28	22	0	0	50	122	0.488	6

Figure 3 gives graphical representation of relative importance index of factors responsible for adopting modern formwork system in any project. The graph plotted between various factors and RII of respective factors.

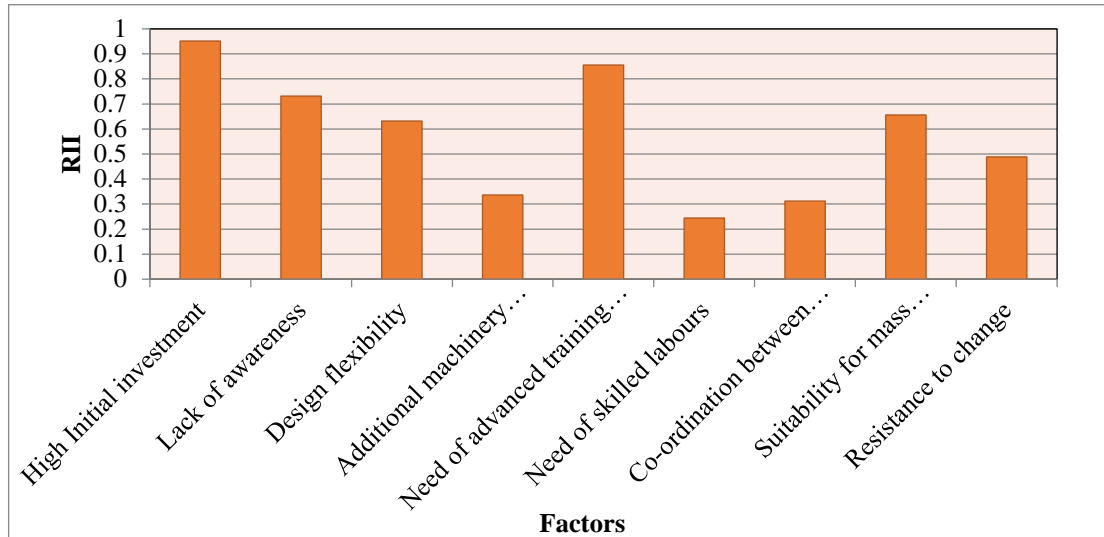


Figure 3: RII of factors responsible for adopting modern formwork system

Figure 4 illustrates percentage of responses given to factors responsible for adopting the modern formwork system by respondents. High initial investment, Advanced training sessions, lack of awareness are the top ranked factors whereas co-ordination between different agencies and skilled labour requirement are least important factors that are responsible for adopting modern formwork system. To high initial investment about 76% respondents has given weightage of 5, 24 % of respondents has given weightage of 4, 0% responses are obtained for weightage 1,2 & 3. To lack of awareness about 10% respondents has given weightage of 5, 46% respondents has given weightage of 4, 44% respondents has given weightage of 3. For design flexibility about 16% respondents has given weightage of 4, 84% respondents has given weightage of 3. To additional machinery requirement about 20% respondents has given weightage of 3, 28% respondents has given weightage of 2, 52% respondents has given weightage of 1. To advanced training sessions about 28% respondents has given weightage of 5, 72% respondents has given weightage of 4. To skilled labour requirement about 6% respondents has given weightage of 3, 10% respondents has given weightage of 2, 84% respondents has given weightage of 1. For co-ordination between different agencies 20% respondents has given weightage of 3, 16% respondents has given weightage of 2, 64 % respondents has given weightage of 1. To suitability for mass housing projects 28% respondents has given weightage of 4, 72% responses are given weightage of 3. To the factor of resistance to change about 44% respondents has given weightage of 3, 56 % respondents has given weightage of 2, 0% responses are obtained for a weightage of 5, 4 & 1 respectively.

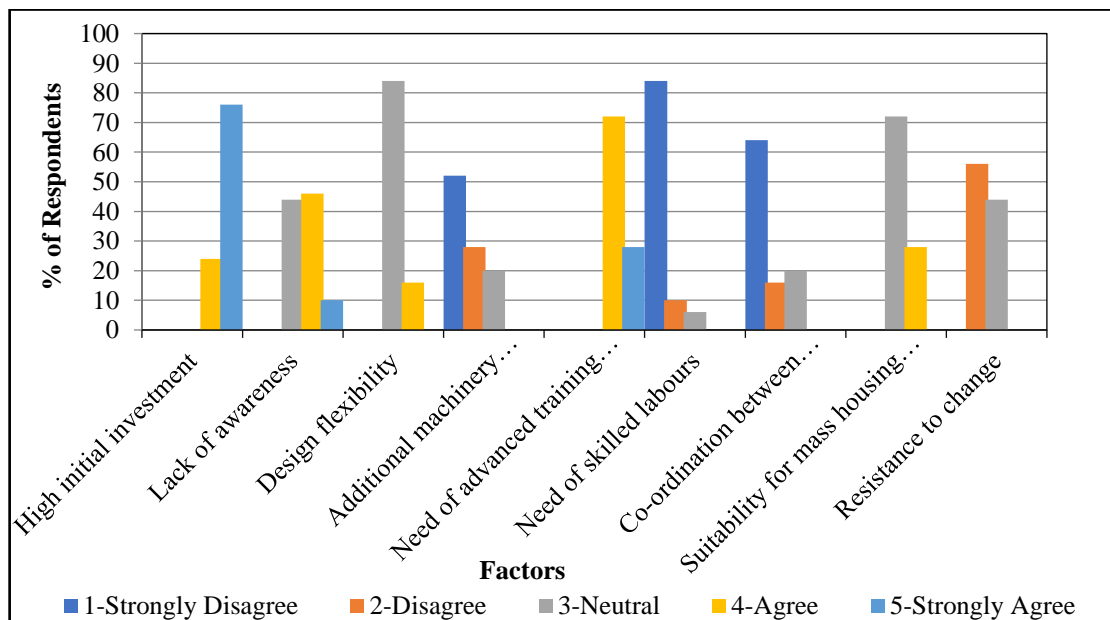


Figure 4: Percentage Response rating of factors responsible for adopting modern formwork system

The computed RIIs and their respective ranks as perceived by respondents for the enablers for adopting modern formwork system are summarized in Table 3. From table 3 most important factors according to the perception are awareness programs, framing of standards and guidelines, proper training of labours. According to the respondents it seems that awareness programs is the most important factor as it has the first rank among all factors with relative importance index (RII) equal to 0.968. Proper training of labours has been ranked in second position by the respondents with RII equal to 0.820. Framing of standards and guidelines has been ranked in third place with RII equal to 0.780.

Table 3: RII & Ranking of factors considered as enablers for adopting modern formwork system

Factors	Response					Total (N)	ΣW	RII	Rank
	1	2	3	4	5				
Awareness programs	0	0	0	8	42	50	242	0.968	1
Framing of standards & guidelines	0	0	15	25	10	50	195	0.780	3
Proper training of labours	0	0	0	45	5	50	205	0.820	2

Figure 5 gives graphical representation of relative importance index of factors considered as enablers for adopting modern formwork system. The graph plotted between various factors and RII of respective factors.

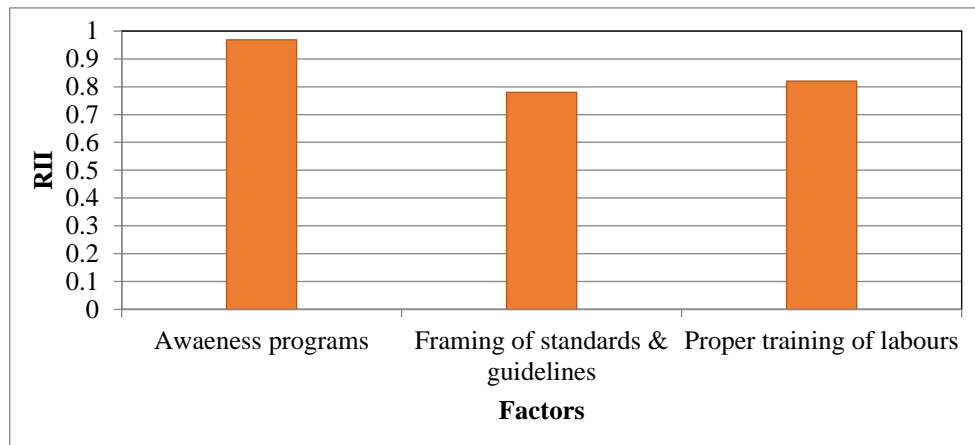


Figure 5: RII of factors considered as enablers for adopting modern formwork system

Figure 6 illustrates percentage of responses given to enablers for adopting modern formwork system. For awareness programs about 84% of responses are obtained for weightage 5, 16% of responses are obtained for weightage 4, 0% responses are obtained for weightage 3, weightage 2 and weightage 1 respectively. For framing of standards & guidelines 20% responses are obtained for weightage 5, 50% responses are obtained for weightage 4, 30% responses are obtained for weightage 3, 0% responses are obtained for weightage 2 & weightage 1. To proper training of labours 10% responses are obtained for weightage 5, 90% responses are obtained for weightage 4, 0% responses are obtained for weightage 3, weightage 2 & weightage 1 respectively.

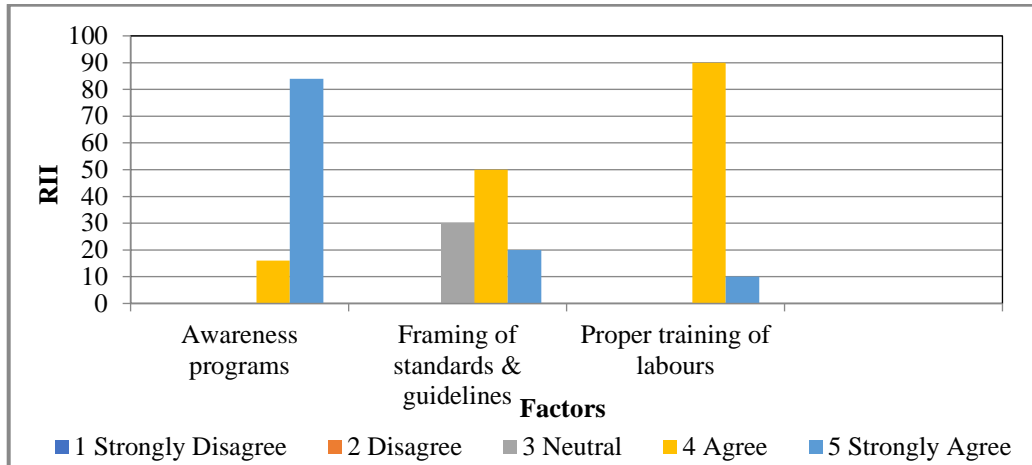


Figure 6: Percentage Response rating of factors considered as enablers for adopting modern formwork system

III. CONCLUSION

We can conclude that the conventional methods of formwork system are economical for small scale projects. While the modern-day methods are economical for high growth mass constructions. The modern techniques save cost for construction work and period of construction work. It is rapid construction technique in which construction take place at high speed. Likewise it is offering high quality of construction and low maintenance. The surface finishing of modern form gives better finishing so, plastering of surface is not required and directly we apply putty or paint.

I. Most important factors according to the perception are found out which are considered during the selection of formwork for any project are Cost, Quality, Safety, Labour availability, Cycle time, No. of repetitions, Hoisting techniques. According to the respondents, it seems that Cost is the most important factor as it has the first rank among all factors with relative index (RII) equal to 1. Quality has been ranked in second position by the respondents with RII equal to 0.940. Safety issue has been ranked in third position with RII equal to 0.832. Labour availability has been ranked in fourth place with RII equal to 0.660. Cycle time has been ranked in fifth place with RII of 0.556.

II. Total 9 factors are found out which are responsible for implementing advanced formwork system. They are identified through literature study & questionnaire survey. A questionnaire survey was conducted on high rise building construction projects (above G+5) to find out factors influencing formwork selection in construction projects. According to their rank indexes the top 5 factors has been ranked. The top 5 factors are High initial investment, Advanced Training Session, Lack of awareness, Suitability for mass housing project, Design flexibility.

III. The enablers for adopting modern formwork system according to the perception are awareness programs, framing of standards and guidelines, proper training of labours.

a. According to the respondents it seems that awareness programs is the most important factor as it has the first rank among all factors with relative importance index (RII) equal to 0.968. In order to maximize the quality with reduction in time and cost, constructors need to focus on innovations taking place around them. This simply needs initiatives to enhance production.

b. Proper training of labours has been ranked in second position by the respondents with RII equal to 0.820. Internal training workshops can be conducted by the companies to improve the skills.

c. Framing of standards and guidelines has been ranked in third place with RII equal to 0.780.

IV. From the study it is concluded that mivan formwork and tunnel formwork is cost effective, time efficient and produces better quality if the quantum of work is more. Modern formwork systems, which are mostly modular, are designed for speed and efficiency. They are engineered to provide increased accuracy and minimize waste in construction.

V. The main systems in use are mivan technology and tunnel form. This guide sets out their key features – process efficiency, safety, sustainability and other considerations – in order to help construction professionals to take advantage of them to achieve modern, efficient concrete construction.



VI. By using mivan system & tunnel form system we can achieve cost reduction in less time. By reducing cycle time than conventional method overall financial cost saving can be achieved.

VII. However, due to lack of expertise and qualified workers, executing these modern formwork systems on construction sites is far from satisfactory. Enablers like awareness programs, proper training for labours, Framing of standards and guidelines will encourage the use of modern formwork systems in the Indian construction industry.

REFERENCES

- [1] Deep Jayesh Mistry, Prof. Amit D. Raval, Dr. J. R. Pitroda (2021) "Emerging Trends in Advancement of Formwork"- International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429 Volume:09 Issue:III
- [2] Prasad Kolekar, Vishwajeet Nigade, Shivaji Hajare, Prathamesh Kamble, Sagar Patade, Amit Kumavat (2020) "Analysis and Comparison of Mivan Formwork System with Conventional Formwork System"- International Research Journal of Engineering and Technology (IRJET)
- [3] Bhagirathi Singh, Dr. Pankaj Singh (2019) "Comparative Analysis of Tunnel Formwork System & Conventional Formwork"- International Journal for Scientific Research & Development [IJSRD]- ISSN: 2321-0613- Volume: 06, Issue:12
- [4] Sharmilaa.S, Vanitha.B (2019) "A Case Study and Comparison of the Conventional Formwork, Tunnel Formwork and Aluminium Formwork Systems"- Infokara Research ISSN NO: 1021-9056, Volume:08 Issue:10
- [5] Vallabhy.S, Ajithkumar .M, Dinesh.A, Harikrishnan .A, Karthickyadava .P.K (2018) "Advanced Technology for Speedy Construction (Tunnel Formwork)"-International Journal of Creative Research Thoughts(IJCRT)- ISSN: 2320-2882, Volume 6, Issue 2
- [6] Aaqib Majid Khan, Chitranjan Kumar (2017) "Impact of Mivan Formwork over Conventional Formwork"- International Journal of Science and Research (IJSR)- ISSN (Online): 2319-7064, Volume :06, Issue: 07
Volume: 07 Issue: 06
- [7] Hemendrasinh Chauhan, Dr. K B.Parikh (2017) "Comparison and Effectiveness of Mivan Formwork over the Conventional Formwork"- Journal of Emerging Technologies and Innovative Research (JETIR)- ISSN:2349-5162, Volume: 04, Issue: 12
- [8] Vasav R. Rakholia, Srinil H. Soni (2017) "Comparative Studies of Construction Techniques (Conventional vs Mivan)"- International Research Journal of Engineering and Technology (IRJET)- Volume: 04, Issue: 1
- [9] Mayur Sanjay Lodha, Kiran Anil Tambe (2017) "Comparative Study of Mivan Formwork with Tunnel Form System for High Rise Building" - International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 p-ISSN: 2395-0072 Volume: 04 Issue: 11
- [10] Bhagyashri Wani (2017) "Analysis of New Formwork Technology adopted on a Construction site in Pune"- International Journal of Innovations in Engineering Research and Technology [IJIERT]-ISSN:2394-3696 Volume:04, Issue: 11
- [11] Harsh Kataria, Krapanshu Khandelwal, Prateek Kanojiya (2017) "New Construction Techniques for Affordable Housing in Fast Track Manner"-International journal of Research- e-ISSN: 2348-6848 p-ISSN: 2348-795X Volume 04 Issue 10
- [12] Asst. Prof. A. R. Chavan (2016) "A Review on Fast Track Construction using Modern Formwork Systems"- International Conference on Recent Trends in Engineering, Science & Management
- [13] Arbaz Kazi, Fauwaz Parkar (2015) "Comparative Study and Decision Making for a Formwork Technique to be Adopted on a Construction Site in Mumbai"- International Journal of Research in Engineering and Technology- ISSN(e): 2319-1163, ISSN(p): 2321-7308 Volume: 04 Issue: 12