ANALYSIS OF DEFECTS IN PRECAST CONSTRUCTION

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Abstract: Defects are major problem in construction sector which have significant impact on construction performance. Defects are not based on single outcome; it occurs when multiple interrelated causes are combined. In order to apprehend the need for improvement in the construction industry and to better manage our projects and construction companies, we need to minimize defects and look for method to do so. This study investigates causes of defects in precast construction, and finds total cost of rework which is associated with that defect. This paper also focuses on how rework affects the productivity and added extra time and cost to the project. This paper makes a contribution to knowledge in the area of construction engineering and management which help for researcher to understand about defects in precast construction.

Index Terms **- Defects, Precast construction, Construction management.**

I. INTRODUCTION

Defect is a building imperfection or design mistake that reduces the value of the building, and causes a dangerous condition. A construction defect can arise due to many factors, such as poor workmanship, use of inferior materials, atmospheric pollution and climatic conditions are more frequent. Defective building construction not only contributes to the final cost of the element but also to the cost of maintenance. Conditions under which building construction takes place are often far from ideal with the focus mainly being on fast delivery. Defects resulting of inaccurate construction can be avoided by ensuring that proper inspection tools are in place. The understanding of building defects and their causes is necessary for better performance of any building. Broadly speaking, building defects fall into two categories i.e. defects that affect the performance of structure and defects that affect the appearance of structure. In precast construction most of structural elements are systematize and produced in plants in a location away from the building and then transported to the site for erection.

II. LITERATURE REVIEW

Many researchers have been focused on defects, rework and failure in construction industry. It must be clear from the bulk of these publications related to defects and rework. Researchers discuss the number and range of characteristics of defects and rework, make solid attempts to quantify costs. Origin of defects occurring during production is principally in production, researcher quantify cost, 54% of the defects cost could be attributed to production, 34% to the site management and 20% to workmanship suggested by (Josephson *et al*.,1998). Endogenous organizational factor is the main causes of defects, suggesting that improvement can be found on the management and strategic levels within projects instead of the operational level (Jingmond *et al*., 2015). Designer can improve overall building quality by consolidating efforts on a few major defects and gathering existing knowledge from the property managers (Chong Wai- Kiong *et al* ,. 2006). Defects classification and validation system which will help construction companies to implement in their tracking system it will help understanding the nature of defects and it will facilitate the development of strategies to reduce or prevent defect (Macarulla Marcel *et al* ,. 2013).

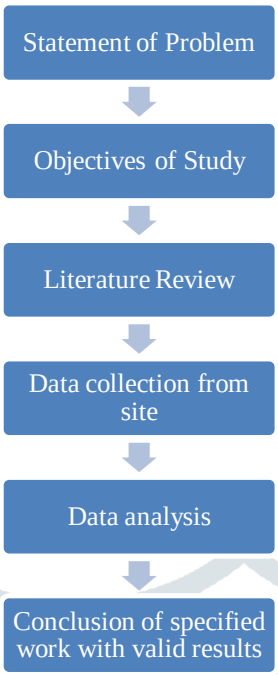
III. PROBLEM

The aim of this study is to identify the defects in precast construction, causes of defects, how do contractors protect themselves from this liability, and what do when we discover defects. Will this directly affects the organizational performance in construction project?

IV. Objective

- Determine the types and causes of defects in precast construction
- To evaluate the cost associated with defects and
- To analyze the productivity loss due to defect.

V. Methodology



VI. Defects in Production Plant

All the data has been collected from precast production plant and site. Different defects have been finding in this study for a project.

6.1 Column

For every element there are number of sleeves for connection of elements and for grouting in precast construction. After the casting of various elements, many sleeves are displaced from their actual position and it takes time to find out that sleeves Figure 6.1.a shows that a hole which is made by labor while finding the sleeve and the size of hole is 250mm* 230mm* 230mm. A Column is casted transported to the site for erection, before the erection it is found that column is more in length. Column sent back to the production plant and converted into actual length as per drawing shows in figure 6.1.b

Figure 6.1.a: Defective Column

Figure 6.1.b: Column Breaking

6.2 Shear Wall

Shear wall is structural element used to resist lateral forces. Figure 6.2.a shows that shear wall casted without 25 screed bar (screed bar is used for connection of two elements). Figure 6.2.b shows that screed bar is given in drawing but not provided in actual.

Figure 6.2.a: Casted without screed bar

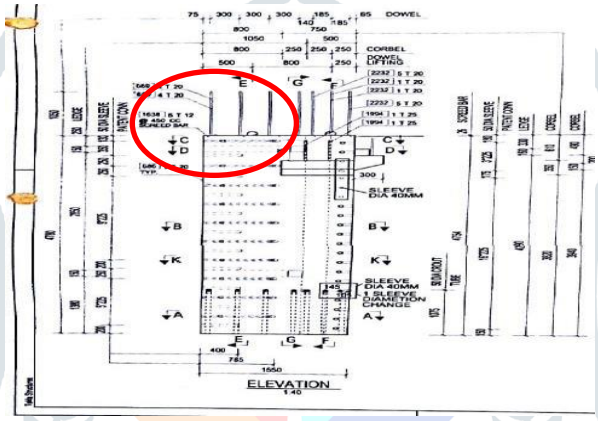


Figure 6.2.b: Casted without screed bar

6.3 Hallow Core Slab

It is also know for voided slab, a precast slab of pre stressed concrete used in construction of floors in multi-storey building. Hollow core slab plank is placed as one continuous piece of concrete and then cut to required length after curing. Factors for crack in hallow core slabs are improper curing, cutting of strands, cutting of slab and lifting of slab. Types of crack in hollow core slab are longitudinal crack at void, longitudinal crack at web, transverse crack and corner crack. Figure 6.3 shows that major longitudinal web crack formed up to 2.5m of total length of slab, which has been observed after cutting of slab in required length.

Figure 6.3: Major Crack in Hollow Core Slab

VII. Defects in erection of element

7.1 Ramp for basement

Ramp is constructed by using hollow core slab. In precast construction floor screed is required on the top of hollow core slab. The main purpose of screed is to provide a smooth surface and maintain the level of slab. Figure 7.1 show that slope of ramp, which is 360mm down after the screed slab from adjacent floor level. Huge amount of concrete is required at the top of ramp to maintain the level of ramp and floor.

Figure 7.1: Ramp for basement

7.2 Gap between Hollow Core Slab and Beam

Gap between hollow core slab and beam is 110 mm shows in figure 7.2 Length of hollow core slab is 7700mm and width is 1200mm but the adjacent slab is less in width which is the cause of gap between slab and beam.

Figure 7.2: Gap between Slab & Column

7.3 Retaining wall and Cast in Situ column rework

A snag list was prepared for basement B1 & B2 for retaining wall and cast in situ column joint there are 96 columns are defected out of 134 due to improper formwork. The term defect and rework can encompass a substantial range of problems that could be discovered within newly constructed building, usually during a process termed the “snagging. Figure 7.3 shows that rework of column.

Figure 7.3 Rework of Column

VIII. Data analysis and discussion

8.1 Defects Severity

Defect severity indicates the extent to which the defect affects the performance of structure. Severity can be of following type:

i. Minor: Minor defect is a variation from the standards, but one that is not likely affect the usability of structure.
ii. Major: Major defect is one which is likely creating failure of the element.
iii. Critical: A critical is one that is deemed to be hazardous or unsafe.

8.2 Stages in precast construction:

Precast construction required more stages as compared to the cast in situ construction. All defects have been found in different stages and these stages are:

i. Released drawing of every element
ii. Planning and scheduling for casting and erection of elements
iii. Casting of elements in production plant
   a. Pre Construction (Pre-Con)
   b. During concreting (Dur-Con)
   c. Presetting
   d. Post finishing
   e. Production stockyard
iv. Transportation of elements (loading & unloading)
v. Erection of elements

In Precast construction, drawing of every element release in production plant for casting of element according to plan and schedule of construction. For every project there are thousands of drawing for different structural elements, it is hard to track or find all these drawings. Revision in drawing is extremely critical problem in design and detailing department. Drawing which is released for casting of element i.e. R0 drawing. If any design deficiency find in R0 drawing then R1 drawing released after the correction in drawing. Figure 6.1.b shows that column breaking by labor due to design deficiency and that is critical defect which required more time and cost to rework. Ramp which is shows in figure 7.1 have design deficiency, top level of hollow core slab is not as same level of adjacent floor level, which create problem to make perfect slope for ramp. Total extra concrete required to make slope is 9 cum and it also added extra time and cost.

There are various change causes for revision in drawing and frequently change causes in drawings are:

i. Changes in dimension of element
ii. Changes in corbel location
iii. Changes in ledge dimension
iv. Changes in grouting sleeves
v. Changes in steel cage

Figure 6.1.a shows a hole which is made by labour in post finishing stage of element. This major defect has been found in post finishing stage of element. Figure 6.2.a shows that shear wall casted without screed bar, origin of this defect is in pre construction stage but defect have been find by quality engineer in post finishing stage of element. This is due to lack of supervision from quality and production team.

Main causes of crack in hollow core slab are due to improper curing and mix proportions of concrete, inappropriate water cement ratio in concrete, rapid moisture loss, heat applied too early, excessive curing temperatures and differential in curing. Figure 7.2 shows that gap between HCS and beam after the erection of element, origin of this defect is post finishing stage of element but found after the erection of element. Cause of this defect is lack of skilled supervision. Total 38 hollow core slabs are recast due to defect.

Snag list which was prepared for rework of cast in situ column and retaining wall joint. The main causes of this rework are improper formwork for every single joint and there is no incline supports has been provided for column. This is due to lack of supervision, wrong workmanship and poor management.

Cost of every rework has been calculated by considering manpower, material and machinery.

Table 8.1 Cost of rework, stage and type of defects

Sr. No.	Rework	Rework Cost in Rupee	Stage	Type of Defects
1	Hole in Column	2,250	Post finishing	Major
2	Column return from site	14,006	Erection	Critical
3	Shear Wall	3,480	Post finishing	Major
4	Hollow Core Slab for 38 slab	2,555,947	Presetting, Post finishing, production stockyard	Critical

5	Ramp for basement	34,425	Erection	Critical
6	Gap between Hollow Core Slab and Beam	1,704	Erection	Minor
Sr. No.	Rework	Rework Cost in Rupee	Stage	Type of Defects
7	Retaining wall and Cast in Situ column	120755	Erection	Critical

8.3 Rework Percentage

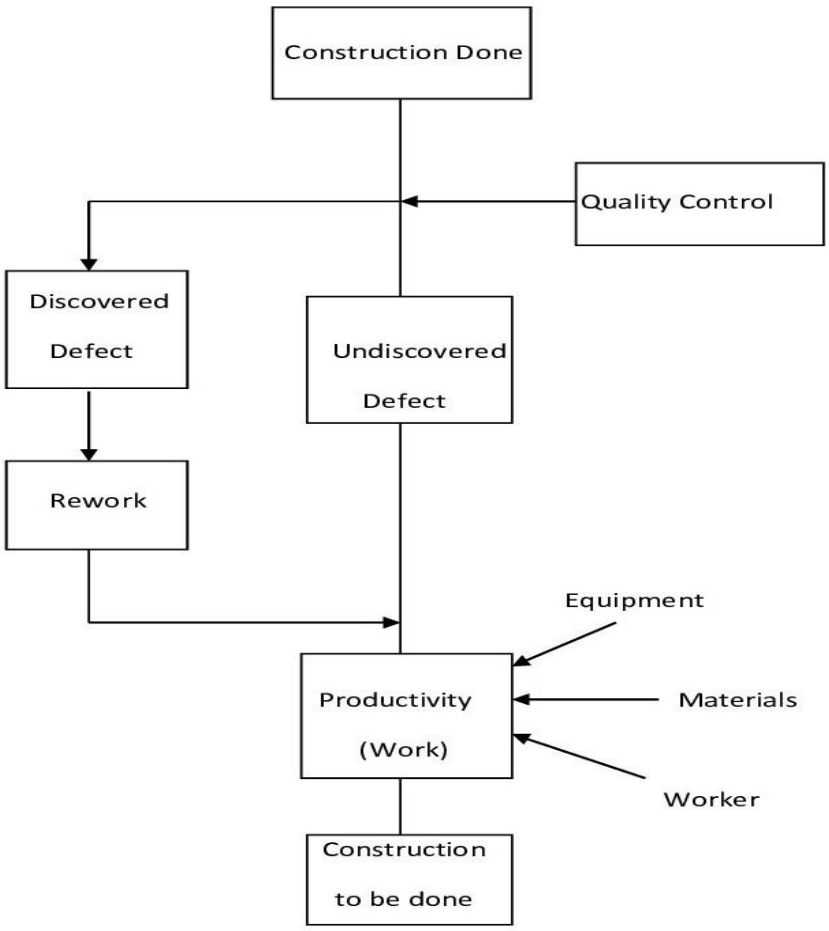
i. Total cost of rework is Rs 2,732,567.
ii. Total cost of project is Rs 380,000,000.
iii. % of rework= 0.72%

IX . Loss in productivity

Construction has an immense productivity problem. This is one of the largest industries in the world and growing rapidly with a major driver of meeting infrastructure needs for an increasingly urban population and the rapid growth of emerging markets.

Loss in productivity reduces the performance, increase the actual completion period and indirectly increases in total cost of construction. One of the causes of variation between actual and standard productivity is due to the defective work done. Loss in productivity due to defects is critical issue which creates many problems in construction industries and directly affects the organizational performance. Completion of project within stipulated time and cost is the main focus for contractors. Speedy construction for early or on time completion of project may be cause of defect. A flow chart 9.1 shows that the productivity loss due to defects, which shows that how extra cost, time and material are required for rework. Rework, is one of the main causes of unnecessary costs and headaches in the industry, affecting every process. The size of problem is directly linked to the size and complexity of each project, and future buildings are face down to continue increasing in both scope and complexity.

Flow Chart 9.1: Productivity loss



Discovered and undiscovered defect both required rework and for that three basic things are necessary worker, equipment and material. It has been finding that due to rework, performance of productivity decrease and it added the following things;

a) More cost
b) More time
c) Less quality
d) More frustration
e) Bad impact on reputation of contractor's firm

X Conclusion

The ability to understand the causes of defects is essential for preventing and eliminating theses defects. Based on the result of the data analysis for defects in precast construction, it was found that the improper supervision, lack of coordination and poor project management are the main causes of defects. Precast construction need to be standardized for dimension, transportation, handling and erection of elements. Rework decrease the productivity and added more cost and time for completion of any project.

REFERENCES

1. Ali. A.S& Wen, "building defects: possible solution for poor construction workmanship" Journal of Building Performance K.H (2011) 2(1): 59-69.
2. Ahmad Suffian "some common maintenance problems and building defects: our experiences (2013) "Elsevier, 3(2): 101-108
3. Chong Wai-Kiong and Low Sui-Pheng(2006) "Latent Building Defects: Causes and Design Strategies to Prevent Them" Journal of Performance of Constructioned Facilities 2006, 20(3): 213-221
4. Chong Wai-Kiong and Low Sui-Pheng(2006) "Latent Building Defects: Causes and Design Strategies to Prevent Them" Journal of Performance of Constructioned Facilities, 20(3) ,pp (213-221).
5. Jingmond Monika & Agren Robert (2015) "Unravelling causes of defects in construction" Construction Innovation, 15 (2): (198 – 218)
6. Macarulla Marcel and ForcadaNuria (2013) "Standardizing Housing Defects: Classification,Validation, and Benefits" Journal Of Construction Engineering And Management, 139(8): (968-976)