

Forensic Testing of Existing Structure & Improvement Technique: A Review

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Abstract: Failures and defects in a structure are common phenomena in the construction industry. Negative impacts may occur towards the price, period, and resources of the project. Failures and defects can cause needless everyday expenditure and delays. Furthermore, if this situation is left unreciprocated and unprocessed, it will lead to more serious harms in the future construction projects. So this learning is intended to identify contributing factors to building defects and failures, which regularly occur in a construction project to reduce time and cost involved. This study succeeds in identifying the common contributing factors of the structural defects and the failures in the construction project. Investigation details of the failure will provide many lessons to construction professionals from past failures so that replication of such failures could be eliminated or minimized. "Forensic Engineering is that the study of materials, products, structures or components that fail or doesn't operate or function as designed, causing damage to property. This is useful to develop practices and procedures to reduce the number of failures and to provide guidelines for conducting failure investigation". This study will investigate the cause of the failure of a structurally damaged building & also investigates the strength & life of an existing building. The study examines the effect of the quality of material used for concrete production & also for the check for analysis & designing.

Keywords: Structural Defect, Failure Analysis & Design, Structure Forensic Engineering, Forensic Tests.

I. INTRODUCTION

In today's world of the fast-rising era where the thing of the future boils down to a country's ability to establish world-class infrastructures and magnificent skyscrapers- construction builders, engineers and architects consider the most important aspect of the project itself, the structural stability. Recently if we notice the present problems facing by civil engineers, the first and foremost thing is building failure & its collapse. For this forensic study is very necessary to analyze the failure of the structure. Forensic engineering is typically defined as "the investigation of failures -which starting from the serviceability to catastrophic - which can cause legal activity, including both, civil & criminal". Therefore it includes the investigation of the materials, products, structures or the components that fail or doesn't operate or function as designed, causing personal injury, damage to property or economic loss. The consequences of failure may give rise to an action under either criminal or civil law together with but not limited to health and safety legislation, the laws of contract or product liability and the laws of tort. The field also deals with the retracing processes and procedures leading to the accidents in the operation of vehicles or machinery. Generally, the purpose of a forensic engineering investigation is to locate the causes of failure to get better performance or life of a component or to assist a court in indecisive the facts of an accident. It can also involve examination of intellectual property claims, especially patents. Structure forensic engineering has various services which have shown below:-

Structural forensics services include:-

- **Building code compliance**
- Building envelope evaluations
- Cause and origin determinations
- **Construction defect analysis**
- Dock, seawall, and pier damage evaluations
- Flood depth determination
- Foundation system studies
- Hail damage assessment
- Industrial, commercial, and residential structure investigations
- Repair design and drawing preparation
- Roof evaluation services
- Seismic evaluations
- Stucco/exterior insulation finish systems

- Underpinning design
- Vibration investigations
- Wind induced failure analysis
- Wind vs. Surge calculations

From all above forensic engineering services this study will deal with Building Code Compliance & Construction Defect Analysis.

What Is Construction Failure?

Construction failure may call as “an unacceptable dissimilarity between expected and observed performance”. Failure of the structure, either by design or by exposure to the natural elements, can lead to compromised building performance which will carry Unacceptable aesthetic appearance, Unreasonable maintenance needs, Excessive deformation, Signs of distress, Local failure, Extensive failure but no collapse, Partial collapse, Total failure (collapse).

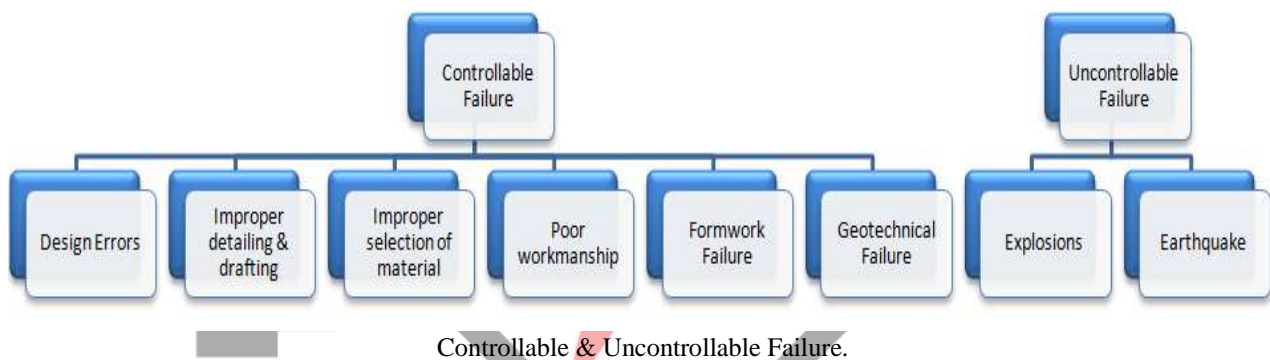
Types of Failure:-

- Failure during construction.
- Failure due to failure of services.
- Failure due to improper maintenance.

Causes of Failure:-

Structural breakdown does not have to be a “disastrous collapse”; it may be a “non consistency with design expectations” or an “incomplete performance”. Collapse is usually the credited to inadequate strength or stability, while incomplete performance or so-called serviceability problems, and is usually the results of irregular deterioration, excessive deformation, and signs of distress.

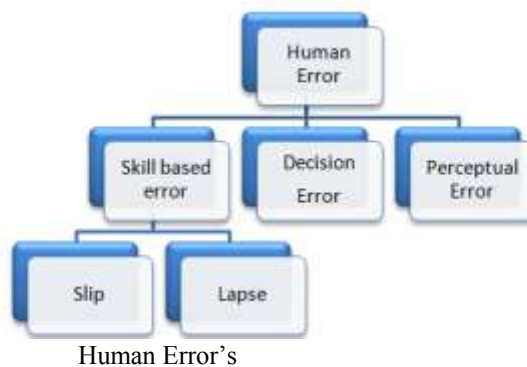
- **Controllable Failure:** - These are the failures which can be control by an engineer, architect, quality control engineer, or by proper supervision.
- **Uncontrollable Failure:** - This kind of failure is sudden failure which is unacceptable & this kind of failure can’t be controlled by anyone. For this while designing the structure there are some factors which is considered by the designer but he designed for a limit of loads according to history of location & surrounding behavior & environmental conditions.



Controllable & Uncontrollable Failure.

Construction failure may also caused by human errors like:-

Sometimes failure occurs due to human miske like somewhere he needs to take a decision but he can’t take or take wrong decisions. This decisions can be taken by having experience or not having experince. It might be design error or his perception towards designing, his approach towards work. Sometimes human lapse somethings it may be slip by mind or forgotten, sometimes his decision may get wrong.



Human Error's

Common Observations which are helpful to find out causes of failure:-

1. External Façade 2. Peeling of plaster and external/internal seepage marks 3. Efflorescence, plinth protection, external drainage, ground water ingress, ground water flooding 4. Overall response of plumbing 5. Building has horizontal and vertical projections 6. Terrace inspection 7. Terrace housekeeping is poor 8. Left RC column stubs 9. Innovative user observations 10. Option for waterproofing.

II. OBJECTIVE

The objective of this study is to find the causes of construction failure and to avoid recurrence of such failures:-

- To review construction failures investigation process.
- Selection of site.
- To collect the test samples of the soil and concrete.
- To determine the strength of a structure & conducting a life period of that structure.
- Mapping out where components ended up comparative to each other, determining how the building was loaded.
- To study the design & analysis of structure, estimating the strength of failed components.
- Determine concept of forensic engineering in construction field.
- To study the reason behind the failure or collapse of the structure.

III. DIFFERENT RESEARCH WORK

[Mel A. Underwood & Andrew W. Johnson et al 2018] The condensation forms due to high moisture, humidity & improper ventilation. According to NWFA moisture percentage 12-13% is normal & above that, it is considered as elevated. In observation it is found that moisture percentage is about 27.2 - 37.2%. The needs for prevention from condensation are vapour barrier sheets & code compliance for condensation.

[Michael P. Lester, P.E., M.ASCE, et al 2018] This study gives a review of design and construction documentation. There is a design failure by the designer which is the main reason of failure. This paper deals more simply with a number of cases in which design errors, some of which were seemingly insignificant, yielded considerable liability for the designer of record.

[Yogen Sadashiv Masurkar¹, Abdulrashid Chand Attar et al 2014] Collapse of (G+3) in khed. Structure was collapsed due to concrete failure. This paper emphasizes on different types of failures and causes for different constructional failures. Various test were conducted on site to identify the cause behind the failure. Strength of concrete is less as compared to design strength. M20 grade req. but by test, strength is about 12.94 N/mm & 10.73N/mm

[D.S. Bhosale et al 2013] This study gives the methods & applications of forensic engineering in construction field. Description about Destructive & Non-Destructive test. This study also suggests a checklist to avoid geotechnical failure & formwork failure.

[Nithin Krishna et al 2012] The structure collapsed due to blasting. An attempt to damage the buildings (world trade centre) by a bomb blast. The reduced structural capacity was the first ingredient in the failure. The second was the heating effect brought on by the burning jet fuel as temperature approach 1500F. The fire caused weakening of the steel and suddenly received a load for which they were not designed. Each tower contains about 1,00,000 tons of steel & concrete.

[Lekan Makanju Olanitori et al 2011] In this study failure of some parts of building occurs under construction. To determine the reason behind the failure Seive analysis, field settlement & compression test was performed & observed that Anchorage length & spacing is not adequate. Anchorage length provided was 75mm but required was 144mm & 192mm. Spacing was 300mm provided and required spacing was 250mm.

[Chandan Ghosh et al 2011] In this study collapse of 1 column out of 12 due to seepage in basement. For this excavation of foundation, checking consistency of sub soil & checked the actual construction with design of building. Estimated load carrying capacity of column is about 108 tons for that req. footing size is 3*3 m but provided 0.5*0.6m. At some junction excessive steel was provided (1-1.2m). Floating wall was constructed which is 50% unsupported, it is a mystery. Column (L>2W) placed along the longer side & it is against BIS code.

[M V Rohith Reddy et al 2009] At around 5:30am on June 27, 2009, an unoccupied 13-storey block of flat building, still under construction toppled over and ended up lying on its side in a muddy construction field. Cause of Failure The cause of the building collapse in Shanghai was due to a pressure difference on two sides of the structure. The collapse was caused by earth, excavated along the building on one side with a depth of 4.6 m, for an underground car park, and piled up to depths of up to 10 m on the other side of the structure. The weight of overburden earth created a pressure differential, which led to a shift in the soil structure, eventually weakening the foundations and causing them to fail. This situation might have been aggravated by several days of heavy rain leading up to the collapse, but investigators did not site this as a crucial factor.

[Wang Yayong et al 2008] The building collapse due to earthquake of high intensity than designed intensity of earthquake. To prevent collapse there should be maximum numbers of internal & external redundancy. Stair case fails because structural partition of lower 1/3 length of stair segment.

IV. NEED OF THE STUDY

The main purpose of study is to inform action, to prove a theory, and contribute to developing knowledge in a field. A Tool for Building Knowledge and for Facilitating Learning. Means to know Various Issues and Increase Public Awareness. The need behind this study is to prevent the structure from failure & make the construction economical. Due to the failure many losses occur like the life of people's, Money losses etc... After this study we can provide the actual strength of the structure by which we can calculate the life of the structure. We can also avoid the unnecessary issues which may occur in future. This study will increase the quality of construction & the material used for construction. This study will also increase our decision making on site or while designing. People will get more aware towards the use of codal provisions & the construction procedure & techniques.

V. CONCLUSION

From the literature reviews, it is observed that failure in a structure occurs due to various reasons during the construction & they are responsible for the failures. As per the study while constructing the structures, testing of soil, sand & concrete should be taken. This study will prepare a structure forensic report of an existing structure & find out the errors in design, on the basis of test results of samples this study will identify the cause of failure & the strength of the structure & this study also provides the prevention from the failure. It has been clear from the previous papers, that this kind of study is done more in foreign countries. There is no awareness in India about this kind of study. This study is aimed to identify contribution factors to building defect and failures, which frequently occur in construction project in order to minimize time and cost involved.

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