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Approach to Assessment of Fire Damages: Composite Structures

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Summary

The case study brings out the innovative approach adopted to assess the fire damage which led to a scientific classification of damages and helped to recommend upgradation and retrofitting. The building was restored in a record time with value added remodeling. The availability of the detailed drawings highlighted the needs for proper documentation. Various innovative techniques to strengthen, join, jacket, and retrofit the structures were used. The outbreak of a fire can never be ruled out but it can definitely be minimized and contained. The case study also highlighted the need to stress on Passive measures in the building design and lay out.

1. Introduction

Vigyan Bhawan in India, is one of the most prestigious and premier conference centres of Delhi. In April, 1990 a fire broke out in the building, which resulted in severe damages to the building structure and services.

2. Approach towards the Restoration

After preliminary assessment of the extent of damage, it was decided to go in for rehabilitation of the main structural elements, for the following reasons.

2.1 As it was a composite structure, the impact of fire left different residual strengths of the structural elements, ranging from negligible damage to extensive damage, rehabilitation would be economical and time saving.

2.2 A totally new structure would have made it difficult to create the original image of the building, which had its own Historical, Cultural and Architectural features.

2.3 Psychologically and Emotionally, it was more conducive for the country at large to have the building renovated as it would also avoid negative publicity. Also the location of the building was in a sensitive VIP area, even controlled demolition would be dangerous.

3. Innovative Management Framework

3.1 The repair and rehabilitation of this prestigious fire damaged building required an innovative approach which had to transcend beyond the normal Engineering approach. The main features were based on Structural, Aesthetic, Fire safety and Security aspects, as given below :

3.2 An apex body was created with representatives of the Administrative Ministry, Construction Agency, User departments, Security and Information services, Architects, Structural Engineer etc.

3.3 The opportunity was used not only to restore the current facilities but also to create modern state of art facilities with enhanced value added services in the shortest time.

3.4 The National Council for Cement and Building Material (NCCBM), New Delhi was

appointed as consultant to assess the structural damage. They assessed the extent of damage caused to all the RCC elements and determined the residual strength of each element.
3.5 A separate set of Architectural consultants was shortlisted, for not only remodeling the existing building design but also to decrease the risk factors, from both fire and earthquake.
3.6 An exclusive Investigation agency was involved in classifying the damage of structures and also making assessment for their re-use.

4. Damage Assessment Procedure

4.1 Debris Inspection.
4.2 Preparation of Structural arrangement plans at different floors, numbering each column, beam, and slab member.
4.3 Visual inspection of structural members including surface appearance of plaster, colour, Crazing etc., assessment of Structural conditions like spalling, cracks, distortion, delamination etc.
4.4 Recording of visual inspection through spread sheets.
4.5 In-Situ non-destruction test including Ultrasonic Pulse Velocity test, Concrete core tests, Schmidt Hammer tests, etc.
4.6 Laboratory tests, Thermo Gravimetric Analysis (TGA) Differential Thermal Analysis (DTA), X-Ray Diffraction (DRD).

5. Classification based on Intensity and type of Damage

5.1 Superficial repairs, consisting of cement plaster etc.
5.2 General repairs, consisting of cement based polymer, modified mortar/Epoxy mortar.
5.3 Principle repairs, consisting of shotcreting in slabs/beams, structural jacketing, epoxy etc.
5.4 Major structural repairs, consisting of demolition, recasting and strengthening, retrofitting.

6. Lessons learnt

The work was completed in 18 months with an estimated cost of Rs 270 Million, economy was ensured in time and cost.
6.1 A view was taken to entrust the work to the same agency which was earlier responsible for looking after the building. It increased the involvement of the agency and prevented witch hunting.
6.2 Though visually it seemed that the whole structure needed demolition, yet on carrying out scientific inspections it was found contrary to the earlier belief.
6.3 Non-structural elements like doors, windows, AC ceiling, contribute to the fire load and fire spread in the building. Thus a need to be vigilant in their use.
6.4 The faults in the working of Electric and AC installation and fire detection system are one of the primary sources of fire incidence.
6.5 As the building was a composite structure of Brick, RCC, Steel trussed roof,it posed complex problems of design and retrofitting.
6.6 A systematic approach with a multi-disciplinary team is very essential in assessing the fire damage and rehabilitation.
6.7 The silver lining to the dark cloud was capitalized by using the incident as an opportunity for giving better and modern facilities.
6.8 While it is always important to find out the causes of fire, it is more important to take steps at the earliest to remove the image of the Catastrophe. Thus, speed in rehabilitation was prime concern.
6.9 It was found that some materials have theoretically independent properties but when used as composite structures, they behave differently.
6.10 Though the design and structural strength are universal but the valuation has to be based on local understanding and safety factors.
6.11 Passive design options while planning and designing of building are the first safeguard for self containment, not only for fire damage but for any other eventuality like earthquakes.
6.12 Structural fire preventive measures need to be seriously considered in design of buildings. Greater stress should be laid in design by using the thick, well covered structural elements, which afford inherent fire protection of Structures and area available.
6.13 Proper documentation and availability of structural designs of the building enabled the teams to correctly assess the reserve capacities of the structural elements.