WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Major Structural and Civil work of Industrial Building : A Case Study

Vivek Singh[1], Shalaka Nawle[2]

CEO, Creative Consultants Mumbai-400053, Maharashtra
Structural Engineer, Consultants Mumbai-400053, Maharashtra

A B S T R A C T

Industrial buildings are buildings which are used for industrial activities and Structural Repairs of such Industrial Buildings can be a tedious process as it requires special attention to its restoration needs and maintenance. Similarly, our project named "Tata steel-6 HI Mill Electric Room Building" at Khopoli, Khopoli - Pen Road is exposed to a dynamic environment and internal higher temperature which goes upto 45 degree Celsius and such effects can create critical and challenging conditions to execution of repair and other related work.……..

Keywords: Structural Repair Work, Civil Repair work, Structural Strengthening, of old Industrial Building.

1. Introduction

The Existing Building i.e. "Tata steel-6 HI Mill Electric Room Building" is a R.C.C. framed & steel structure having Ground + 02 Upper Floors. It is used for electric control roomwhich provide part electricity to production plant for manufacturing colour-coated sheets, high-tensile steel strappings, hardened and tempered steel strips along with CRCA steel to cater to the needs of the automobile industry.

1.1. Analysis of Data

Condition of the common areas like Staircase, Mid-Landing & Passages were found to be in distressed condition with Plaster cracks & Seepage with peeling of paint at several locations are noticed.Debonded plaster and cover concrete of RCC elements were notice in external area of the structure at some places, also some damaged portion of the structure are fallen down.Slab at 01st floor Level was found sagged at few areas which needs to be repaired with Micro Concrete.In short, the entire external part of building is in distressed condition with major cracks and hollowness in RCC elements & plaster, which needs to attend with required methodology for repairs.Few cracks are seen at RCC columns and beam inside the internal areas with separation cracks, and at some location slab found distressed in conditions which needs to attend with required treatment at the earliest.High vibrations observed in this RCC building, during the crane operation and movement.

1.2. Root Caused Identified

Overall condition of structural elements is found in distressed condition, Major structural cracks observed on RCC Column & Beam and it is because of the aging effect and high vibrations in the RCC building, at which requires to attend at the earliest with proper major structural repairs methodology.This RCC building is connected to the crane supporting MS structural columns. Five Nos. of crane supporting MS structural columns are in the middle of this building, which may be connected at some places (At through slab locations) to this RCC building and the vibration are transferring while the crane is in operation and movements. First floor slab found sagged at some location in the building and some cracks observed on it because of Sagging. Whatever structural cracks arisen in the RCC columns & beams and separation cracks observed in this building, which are because of crane vibrations are transferring in the RCC building.

2. Scope of Work

2.1 Scaffolding & Formwork: Support the structure in a particular cell with complete props and shuttering. Access the areas of repair and elements to be repaired by providing and securely fixing safe scaffolding using H-frames /Pipe and coupler system and safe working platforms for the workmen using suitable planks. Support the severely deteriorated RCC elements sufficiently especially columns and major beams beneath by using adjustable steel props before chipping.

Safety Measures: Precautionary measures has been taken in the form of covering external elevational area by safety net to avoid any mishaps and accidents on site.Site safety instructions and training has been provided to workersto maintain efficient and safe working environment.

2.2 Polymer Modified Mortar (PMM) Internal And External R.C.C. Members: As per the observation & detail report, the defect in the RCC members are due to effect of Corrosion. The strengthening of RCC members were done from internally and also externally wherever necessary by Polymer modified mortar (PMM) technique. The detailed methodology is as mentioned below:

A. Surface Preparation- Chipped-off and removed all the loose concrete from deteriorated /damaged concrete portions of columns, beams, slabs, etc. by using vibration less electrically operated chippers (Chippers of 4 Kg) and expose the sound concrete, de-rust existing reinforcement with electrically operated rotary grinders with cup-brush, wire brush or sand paper. Used portable air blowers to make the surface free from loose material, dirt, etc. as the surface preparation is of prime importance for the repairs. Unless the corrosion scales are completely removed before repairs are to be carried out.

B. Alkaline Rust Converting Primer Application- Applied one coat of alkaline rust remover /converting primer (Feovert or equivalent) by brush to rebar's after removing rust and thorough cleaning & leaved it for 6 - 8 hours.

C. Anti-corrosive coating Application- Applied two coats of Anti-corrosive protective coating IPNET –RB for existing exposed and cleaned reinforcement bars with gap of minimum 10 hours in between 2 coats. This Application was done by brush.

D. Application of Concrete Penetrating Corrosion Inhibitor- One coat of Concrete Penetrating Corrosion Inhibitor was applied, which works on Bipolar Inhibition Mechanism EPCO KP100 on entire concrete surface to be repaired by using brush at 4 sq.mt. /lt. dosage. Holes were drilled of 12 mm Dia at 500 mm c/c and inject KP-100 in inside the drilled holes. Consumption per nozzle was 100ml minimum. Concrete corrosion inhibiter was applied to prevent corrosion of embedded reinforcement.

E. Corrosion Protection of existing structure- Sustained release caplets POW throw were inserted by drilling holes of 20mm Dia at 25 mm depth & sealed with PC Putty. POW throw is a unique solution for maintaining the integrity of existing RCC structure from corrosion of rebar. Spacing of Power throw were - a) For RCC Columns- 1 Unit/ RMT from two opposite faces in staggered fashion b) For RCC Beams- 1 Unit/RMT from two faces in staggered fashion c) RCC Slab- In 1mx1m grid, four units.

F. Shear connectors - New reinforcement were fixed where reduction of bar diameter was found by more than 20%, by lapping. This was done by drilling holes, fixing shear connector & tying new reinforcement. New reinforcement bars were also coated with Feovert and IPNET RB as mentioned above.

G. Strengthening of core concrete matrix - The honeycombed concrete and cracks were grouted with low viscosity Monomer- Monopol, for strengthening of existing core concrete. Monopol having low viscosity 2-5cps, cracks and honeycombs in concrete were filled up to full depth of concrete.

H. Cracks Filling– Wider cracks were filled with Epoxy Grout EPCO-KP/HP-250- SLV by drilling the holes of 14mm Dia, at 150mm to 300 mm Centre to Centre through Rohibb Injector & fixing the nylon nipples of 12 mm Dia with injection pressure of 4-7 kg /cm2. Grouting has been done in cracks till the nozzle refused to accept the grout or it flowed from the adjacent nozzle and then the nipples were removed & holes were sealed with non-shrink epoxy putty EPCO 1010.

I. Bonding Coat Application- Two components Epoxy Bond Coat Epibond-21 to the surface was treated for perfect bonding of Old to New Surface.

J. Encasing Micro concrete- The areas where core concrete was found damaged and also the sagged slab at 01st floor level, high strength, free flow non-shrink micro concrete was applied after making necessary arrangements of watertight shuttering and scaffolding when the bonding coat is tacky.

K. Structural up gradation and strengthening- Fiber wrapping methodology at the beam and column were done with the process as below-

Surface preparation: Grinding/ moulding concrete substrate, cleaning with wire brush, rounding sharp edges to min 25 mm radius etc. were done.

Profiling: Compatible primer on prepared substrate was applied, all the holes and uneven surface with were made even by PMM OR Putty.

Wrapping: Wrapping of the fiber sheet to structural element at desired orientation using tamping roller was done to avoid any air voids etc.

Sand pasting: Second coat of saturant after min. 12 hrs.was applied and all air voids if any were rectified thereafter the river sand was pasted on it to make surface rough to take any further finishes

2.3 Core/Diamond Cutting: Building was isolated/separated, from where supporting MS structural columns are going through the middle of slab which is using to operate the crane in the plant. The process was done by diamond/core cutting by the maintaining minimum 6" gap in RCC slab by around the periphery of structural columns at each floor and every slab location of this RCC building to minimize or dissipate the vibration in this building while operation & movement of crane. After completion of the work, the vibration measurement test has been conducted once again and found satisfactory.

2.4 Internal Plaster: Internal Plaster with Birla Putty finish was applied in the internal areas wherever necessary.

2.5 External Plaster: As the existing external plaster has failed due to delamination, crazing and cracks at certain places and hence, Double Coat Sand Face Plaster in patches (25 mm thick min.) in C.M. ratio 1:4 plaster including Drip mould / Bands / Pattas were applied in entire external part of the structure wherever necessary .

2.6 Separation Gap: Separation gaps between brickwork and R.C.C members from externally and internally at many places were done with polymer-based sealant / chemicals after opening the crack properly in "V" and cleaning the loose particles.

2.7 External & Internal Painting: Finally, the building was painted externally with elastomeric based paint & internally by acrylic based paint to enhance the esthetical look and also protect the Plastered Surface of the building.

3. Improvement Observed

3.1 Structural Strengthening: Structural elements were found in distressed condition as Major structural cracks observed on RCC Column & Beam due to aging effect and high vibrations in the RCC building. Proper remedial actions were taken as per requirement of structural members to strengthening a R.C.C. elements with polymer treatment, micro concreting, fiber wrapping technique etc.

(a)(b) **(c)**

Fig. 1 - (a) Polymer; (b) Micro concrete; (c) Fiber Wrapping.

3.2 Micro Concreting at 1st Floor Slab:At First floor slab sagging at some location were observed and because of Sagging some cracks developed on it.To rectify the distress of sagging slab high strength and free flow non-shrink micro concrete was applied with making sure of necessary arrangements such as watertight shuttering and scaffolding etc. After micro concreting treatment said slab found in satisfactory in condition.

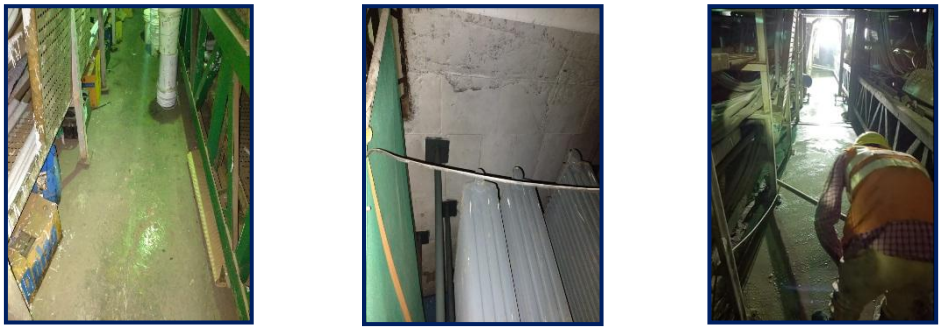

Fig. 2–Slab Micro Concreting

3.3 Diamond/Core Cutting: Building was isolated/separated, from where supporting MS structural columns are going through the middle of slab which is using to operate the crane in the plant. The process was done by diamond/core cutting by the maintaining minimum 6" gap in RCC slab by around the periphery of structural columns at each floor and every slab location of this RCC building to minimize or dissipate the vibration in this building while operation & movement of crane. After completion of the work, the vibration measurement test has been conducted once again and found satisfactory.

Based on both the reports i.e. before execution & after execution, it was noticed that after execution of the CORE/DIAMOND Cutting for separation of crane supporting MS structural columns from the slab of 6 HI Mill Electric Control Room Building, the vibration was found reduced upto 75% than the earlier measured vibration.

Non Destructive Tests were conducted before work execution and after work completion of repair work. Followings are the comparisons between test results which is showing satisfactory work done:

NDT	Before work execution	After work completion
UPV	The readings in this case are in range of 1.02Km/sec to 2.81 Km/sec and the average reading is 1.51 Km/sec, which indicates, poor and loss of integrity exist.	The readings in this case are in range of 3.15 Km/sec to 4.31 Km/sec and the average reading is 4.01 Km/sec, which indicates Good quality of concrete.
RBH	The readings of Rebound Index in this case are in range of 16 to 38 and the average Rebound Index reading is 25, which indicates Fair.	The Average Rebound Index (after mean outliers) are in range of 25 to 33.5 and Average Rebound Index is 31.42 which indicates Good layer of concrete.
Vibration Test	The readings in this case are in range of 4.26 to 52.06 mm/s, and the maximum number of reading are in the range of 19.92 to 52.06 mm/s, which indicates the readings are in Forbidden category of D and it due to High-Power Motor (Stretch Base) vibration.	The readings in this case are in range of 5.28 to 8.48 mm/s, at total 12 Nos of Vibration measured at 12 different locations in all floor and 08 number of reading are in the range of 5.28 to 8.48 mm/s, which indicates the readings are in Satisfying category of B, Reading of 01 Location is "C" (Not Satisfying) and 02 Locations are "D" (Forbidden). It was due to High-Power Motor (Stretch Base) vibration.

4. Conclusion

All the retrofitting work were carried out as per the specifications of tender documents, which was prepared considering the site condition and under supervision /Instructionsof M/s. Creative Consultants as well as Co-operation /Guidance of Tata officials.After completion of the recommended repairs, the said structure is safe and stable for the purpose it is intended to be used, subject to maintenance and required repairs at time to time and no further addition/alternation OR any type of loading pattern made by client.

It is mandatory to conduct structural Audit of the Building/Structure to know the conditions building / structure. Hence, a structural audit must be conducted once in every 3 years to find out the performance and health of building. All industrial structures age and undergo changes over time that may make them unsuitable for use. It is necessary to maintain structure's useful life to carry the repair and the strengthening of these structures periodically.

Acknowledgements

The authors acknowledge Tata Officials for giving all technical support and for awarding the work opportunity to carry out the structural and Civil Repair work of."Tata steel-6 HI Mill Electric Room Building".

REFERENCES

Creative Consultants (September 2020),*Structural Audit Report of "Tata steel-6 HI Mill Electric Room Building"*,Mumbai.
Creative Consultants (April 2022),*Post Execution Report of "Tata steel-6 HI Mill Electric Room Building"*,Mumbai.
CPWD (First published in 2002), *CPWD Handbook on Repairs and Rehabilitation of R.C.C. Buildings*, Kshitiz Enterprises, New Delhi.