Additional Life To Temple Structure By Rehabilitation – Case Study

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Abstract

Every structure has its shelf life after which the members of structure requires maintenance for their deterioration and distress in the form of cracking, corrosion etc. The maintenance consist of extensive Rehabilitation and Retrofitting by means of conventional technique such as (RCC jacketing), steel plating or modern technique like Fiber Reinforced Polymer (FRP).

This paper gives a brief case study of structures treated with combination of all sustainable technique for maximum durabilty of structure. The above case study was a tunkey project where design, manufacturing and execution is done by the DGC team.

KEYWORDS

Rehabilitation, Retrofitting, RCC jacketing, Steel Plating, FRP, CFRP, Composite, Carbon laminate.

Introduction

In today's growing economy, infrastructure construction is mainly depended upon Reinforced Concrete as its major construction material. Constantly advancing technologies has made a big impact in the engineering world with its new and emerging technologies, which has brought in new safety rules and requirements. Most of the structures built in remote past by traditional methods have suffered the consequences of extreme loading events over a long period of time. Retrofitting is an approach based on recent technological developments and scientific knowledge, whereby modern construction methods and materials are applied to the repair and strengthening of historical structures. Fiber Reinforced Polymer (FRP) composites are gaining wide applications in retrofitting of Reinforced cement Concrete (R.C.C) structures due to its inherent advantages over the conventional methods of strengthening. FRP is used widely in strengthening of structures facing deficiencies due to usage, design and change in loading. Fiber Reinforced Polymer is used widely mainly due to its ease and fast way of application and as it does not affect the functionality of the existing structure during application. Use of Fiber Reinforced Polymer (FRP) and other advanced conventional technologies of Rehabilitation of heritage structures.

Saptashrungi temple is located in Nanduri, Kalwantaluka, a small village near Nashik in India. Devotees visit this place in large numbers every day. The temple is also known popularly as one of the "three and half Shakti Peethas" of Maharashtra. The present architect of this temple structure is Studio Architectonic and design consultant is Jagdish Deshmukh Consultants.It is a very old structure built in 1700 AD. The temple has undergone renovations recently also with creations of many facilities. The facilities created at the shrine consist of about 500 steps (474 is also mentioned cut into the rock slopes of the hill, from above the road point, leading to the temple entrance, a community hall, a gallery for devotees to form queues and have orderly darshan of the goddess. The steps were built by Umabai Dabhade in 1710 AD. A portico like structure, an addition made to the main shrine of the goddess is attributed to the Satara Commander-in-Chief and the plain structure at the beginning of the last century. Subsequent additions were made by the Chief of Vinchur. Based on the data given by the Client the temple needs to be strengthened/ retrofitted due to severe cracks and spalling of plaster observed in the beams and columns of the structure. Also the results obtained from the core test reports indicate that the strength of concrete is beyond the permissible grade required for such a heritage structure. Hence, DGC Engineering Pvt Ltd proposed to conduct a site visit to study the same and propose a solution.

Investigation

The Non-destructive testing of the structure was carried out by Advanced Diagnostic Laboratory some of the relevant points of the report are as under:-

a) The Ultrasonic Pulse Velocity and Schmidt Rebound Hammer Test Report indicates that the column of ground floor are badly damaged.
b) The testing of concrete reveals that grade of concrete is doubtful.
c) The Columns of Ground floor show large distress.
d) The grading of concrete is poor as confirm by the Rebound Hammer test.
e) The chloride test report it is clearly shown that the values are higher than the limiting value, it confirm that corrosion has taken place in the reinforcement.

Structural Modeling

a) Structural analysis of the building frame Has been performed by creating model in STAAD and STRUDS software. Geometry of the model is developed based on the available RCC drawing forwarded by the client. Refer figure 1 and 2 for STRUDS and STAAD model of the building.

b) The concrete grade is considered as M10 for the complete structure. However it is to be noted that the non destructive testing report of the ground floor columns suggest that the pulse velocity test and rebound hammer test result reveal poor quality of concrete i.e grade even lesser than M10. But in the software used for analysis minimum concrete grade taken is M10 and hence considered. It implies that the compressive strength as obtained from analysis will be higher than actual present in the column at site.
c) Reinforcement grade for main flexure reinforcement and shear stirrups is considered to be Fe 415.
d) Nominal cover to reinforcing steel is considered as 40mm for column and 25mm for beams.
e) All column considered as fixed at base.
f) Main basic loads applied on the structure are dead loads, imposed loads, wind and seismic loads
g) It is assumed that concrete and reinforcing steel have not deteriorated and do not have corrosion or loss of strength

Recommendations

- The main structural elements i.e. beams and columns at all the levels which are showing severe cracks needs to be strengthened by providing jacketing after initial surface treatment
- Columns which are badly damaged (20 percent) needs to retrofitted/ strengthened with concrete jacketing with micro concrete of 75 to 100 mm thickness followed by carbon fibre wrapping and rest of the columns which shows damage needs to be fibre wrapped after surface treatment to increase the strength and prevent damage in future.
- Beams which show damage needs to be carbon fibre wrapped after proper surface treatment.

Site Visit Visual Observations

SR.NO	PHOTOS	DESCRIPTION
1		Damage observed in internal beams due to peeling of plaster
2		Severe spalling of cover and corroded reinforcement exposure observed in beams
3		Severe cracks and spalling of cover with corroded reinforcement exposure observed in beams

4			Spalling of plaster observed in columns at core cutting locations
5			Severe cracks observed at beam bottom
6			Cracks observed along the length of columns

7		Severe cracks observed along the length of column and along the beam column junctions
8		Severe cracks along the length of beams seen

9		Severe map cracking observed at beam bottom
10		Popout observed in beam along with severe cracks along the length
11		Cracks in column along with at the junctions observed

12		Peeling of plaster observed at certain locations of columns
13		Severe spalling observed in column and corroded reinforcement exposure observed
14		Spalling of cover and corroded reinforcement exposure observed in columns
15		Poor quality concrete observed in the roof beams

16			Surface crazing due to alkali aggregate reaction observed in beams
17			Surface crazing observed in columns

Structural Treatment Veiw :

1		Surface Peparation of Column
2		Application of Anti-corrosive coating.
3		Drilling for shear connector

4		Additional new reinforcement
5		Micro-concreting of column.
6		Epoxy putty application on beam
7		Carbon fiber wrapping on beam (430 GSM)

8		Fixing of carbon fiber anchor.
9		Strengthened beam after fiber wrapping.

Conclusion

Its a challenging experience to Retrofit Saptashringi temple (Shakti peeth in India) 700 steps high on steep mountain . All Tuesday, Friday and all other auspicious day the temple was over crowded. So without disturbing pilgrim the entire retrofitting scheme was implemented. At present, column and beam were strengthened for future life; the slab on top floor needs to be addressed in second phase.