CE&CR AWARDS 2023

Category: Repair & Rehabilitation of Structures

Winner

Rehabilitation of Spiritual Monastery Shri Badrika Ashram in Himachal Pradesh

By DGC Infrastructure Pvt. Ltd.

The case study explores the difficulties encountered during the renovation and repair of Sri Badrika Ashram, a revered residence situated in the mountainous region of Himachal Pradesh. Building on slopes poses unique dynamics and irregularities that demand special attention. The lack of proper planning and design in hilly regions has resulted in haphazard development, necessitating the rehabilitation of structures over time.

This state-of-the-art review examines the variables that affect how retrofitting of buildings on slopes is carried out while elucidating the aspects that have recently resulted in significant challenges during the retrofitting and rehabilitation of buildings.

In around 2018, Sri Badrika Ashram was built in Sirmour, Himachal Pradesh. The structure is made up of 3 floors of sadhak rooms on the lower ground level, an auditorium on the higher ground level, and 3 storeys of suite rooms above that level. The key section of the same is seen in Fig. 2.

The existing structure of the Ashram Building is the RCC Moment-resisting frame. Infill walls are of brick masonry and the floor slab is acting as a rigid diaphragm.

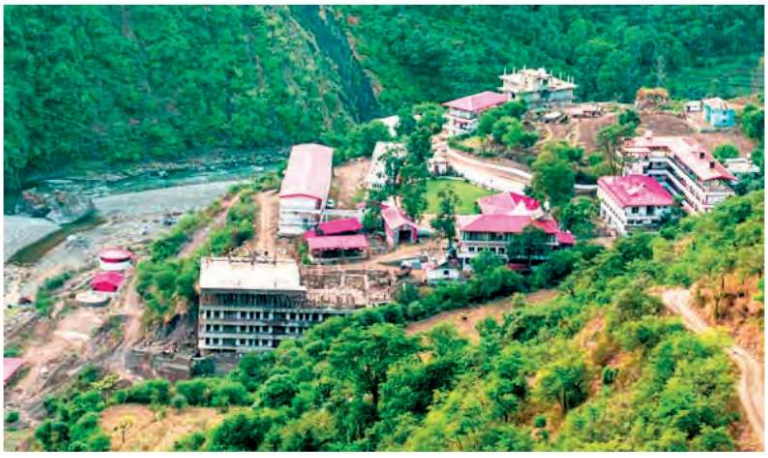

Fig. 1: Shri Badrika Ashram, Himachal Pradesh

A counterfort retaining wall with weep holes has been constructed to retain the earth pressure from the upper ground side and connected with floors at the upper ground floor level (Third slab level of sadhak rooms). As per the original structural drawings, the foundation system is Isolated footing at different levels.

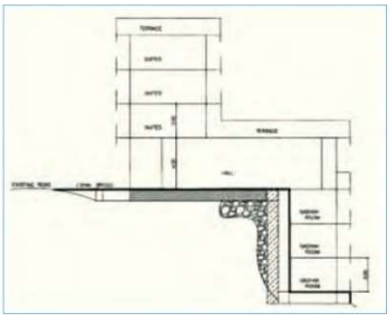

Fig. 2: Key Section

Distress in Structure

The building started showing visible distress within a few years of construction. Interior partition walls had diagonal cracks as shown in Fig. 3.

Fig. 3: Cracks in Structural Members

Reinforcements were exposed in the lower plinth level and there was extensive honeycombing observed in the structure.

Fig. 4: Rebar Exposure and Honeycombing in Concrete

Case Evaluation

In the first stage, a structural audit of the building was carried out to assess the quality of concrete, and grade of concrete construction using the CAPO test as per ASTM standards. Vertical alignment of the building was also assessed. Based on the structural audit, it was found that the building was constructed with a lower grade of concrete as compared with the original design grade. Further, the investigation revealed that the building is tilted from the back side in both directions in the order of 1.5 degrees.

Using the details obtained from the audit, the dynamic behavior of the building was analyzed under as-built conditions and deficiencies in the structural frames were obtained.

Course of Action: Retrofitting

- The columns below the lower plinth level had lower strength hence jacketing of the columns below the plinth has been undertaken.
- The subgrade at the foundation level of columns of the sadhak rooms was stabilized by pressure grouting of cement.
- The foundation of the sadhak rooms is isolated footings at different levels and sizes such that the bearing pressure may reach a very high value and may cause uneven settlements. Column foundations of the sadhak room were connected through a raft between Grid J-1, K-1, J-2 and K-2. Other foundations of a column of the outer grid (valley side) were connected through a 1200 mm wide strip.
- Beams supporting stub columns were implemented with advanced carbon fiber-reinforced polymer wrapping.
- Beam-column junction of the lower terrace level was repaired and strengthened by Epoxy grouting and carbon fiber-reinforced polymer wrapping.

Fig. 5: Column Strengthening

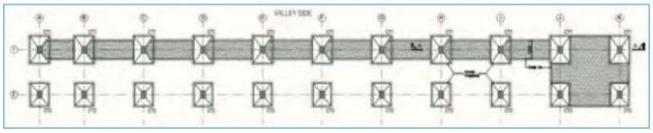

Fig. 6: Foundation Strengthening Layout

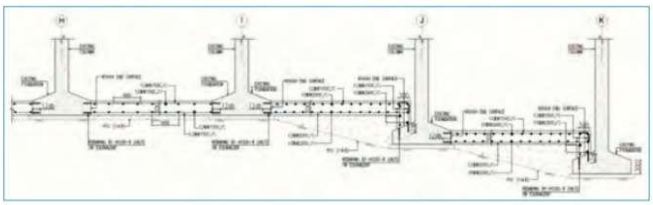

Fig. 7: Sections A-A

Fig. 8: Raft Provision

Fig. 9: Beam Strengthening with CFRP Wrapping

Fig. 10: Column-bean Junction Confinement with CFRP

Conclusion

The execution of rehabilitation in a hill settlement in a constrained hilly area is a tedious and difficult task. In spite of the difficult terrain, extreme weather, material availability and transportation issues, the project was successfully completed and handed over to clients by DGC Infrastructure Pvt. Ltd. in a short period of 90 days.

Acknowledgement

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