BEST: International Journal of Management, Information Technology and Engineering (BEST: IJMITE)
ISSN 2348-0513
Vol. 3, Issue 1, Jan 2015, 5-10

REHABILITATION AND RETROFITTING OF BUILDING STRUCTURES

UMA SHANKAR .K, ARUN PRAKASH .K & PRADEEP KUMAR .S
Assistant Professor, Knowledge Institute of Technology, Salem, Tamil Nadu, India

ABSTRACT

Retrofitting reduces the vulnerability of damage of an existing structure during a future earthquake. It aims to strengthen a structure to satisfy the requirements of the current codes for seismic design. In this respect, seismic retrofit is beyond conventional repair or even rehabilitation. The principles of seismic retrofit refer to the goals, objectives and steps. The steps encompass condition assessment of the structure, evaluation for seismic forces, selection of retrofit strategies and construction. The applications include different types of buildings, industrial structures, bridges, urban transport structures, marine structures and earth retaining structures.

The benefits of retrofitting include the reduction in the loss of lives and damage of the essential facilities, and functional continuity of the life line structures. For an existing structure of good condition, the cost of retrofitting tends to be smaller than the replacement cost. Thus, the retrofitting of structures is an essential component of long term disaster mitigation.

It was proposed to seismically upgrade a seven story non-ductile concrete framed building of early nineties vintage. Analysis results revealed that the structures did not have sufficient structural capacity to resist even a moderate earthquake. To ensure a higher level of safety, reduce the risk of exorbitant repair costs and minimize building downtime after an earthquake, it was intended that the seismic upgrade of the structural system will target the performance standard of 'immediate occupancy'. A dual stage approach was used to address this complex retrofit issue.

The first part consisted of providing robust concrete moment frames in each direction using the time tested jacketing methodology. This ensured adequate strength and stiffness to the structure.

KEYWORDS: Building, Maintenance, Retrofitting, Structures, Concrete, Steel and Polymers

INTRODUCTION

Rehabilitation of Concrete Structures Using Ultra-High Performance Fiber Reinforced Concrete

Concrete structures show excellent performance in terms of structural behavior and durability except for those zones that are exposed to severe environmental and mechanical loading. Rehabilitation of deteriorated concrete structures is a heavy burden also from the socio-economic viewpoint since it also leads to significant user costs. As a consequence, novel concepts for the rehabilitation of concrete structures must be developed. Sustainable concrete structures of the future will be those where the interventions will be kept to the lowest possible minimum of only preventative maintenance with no or only little service disruptions.

Over the last 10 years, considerable efforts to improve the behavior of cementations materials by incorporating fibers have led to the emergence of Ultra-High Performance Fiber Reinforced Concretes (UHPFRC). These novel building materials provide the structural engineer with an unique combination of

- Extremely low permeability which largely prevents the ingress of detriment alubstances such as water and chlorides.
- Very high strength, i.e., compressive strength higher than 150 MPa, tensile strength higher than 10 MPa and with considerable tensile strain hardening and softening behavior. In addition, UHPFRC have excellent rheological properties in the fresh state allowing for easy casting of the self-compacting fresh material with conventional concreting equipment. Consequently, UHPFRC have clearly improved resistance

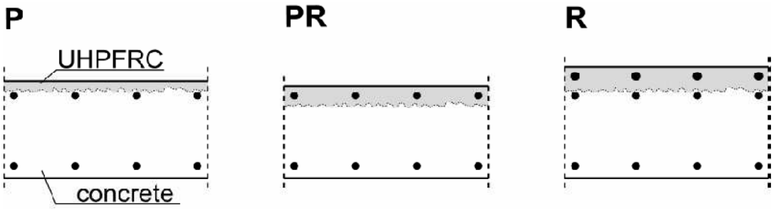

Figure 1: Basic Configurations for Composite Structural Elements Combining UHPFRC and Conventional Structural Concrete

Rehabilitation and Widening of a Road Bridge

A short span road bridge with busy traffic has been rehabilitated and widened using UHPFRC. The entire deck surface of the bridge with a span of 10 m was rehabilitated in three steps during autumn 2004.

Firstly, the downstream kerb was replaced by a new prefabricated UHPFRC kerb on a new reinforced concrete beam which was necessary for the widening.

Secondly, the chloride contaminated concrete of the upper surface of the bridge deck was replaced by 3 cm of UHPFRC in two consecutive steps such that one traffic lane could be maintained open.

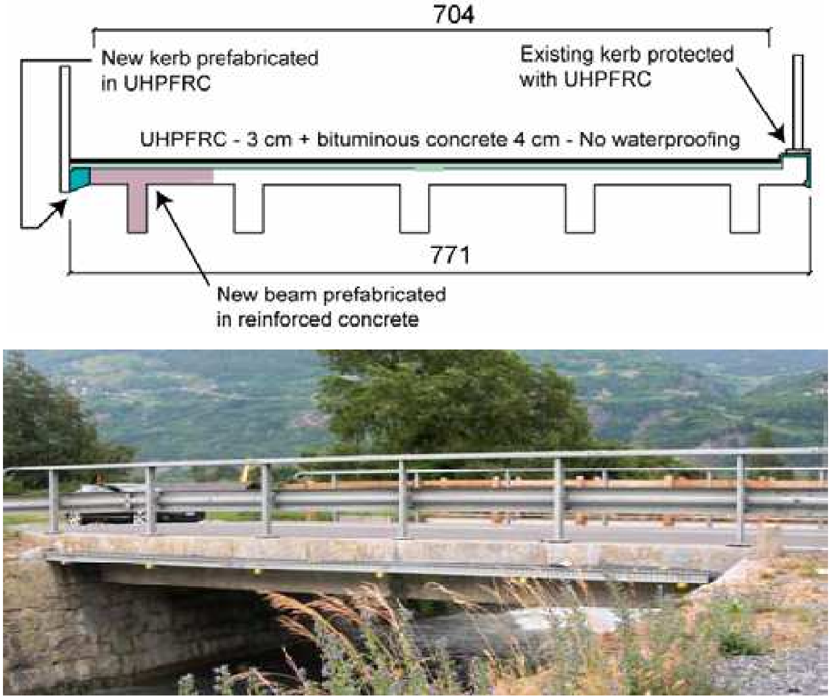

Figure 2: Bridge Cross Section after Rehabilitation

Thirdly, the concrete surface of the upstream kerb was replaced with 3 cm of UHPFRC.

NEED FOR STRUCTURAL RETROFITTING AND REPAIRS

There could be multiple reasons for a structure to undergo retrofitting and/or structural repairs. Some could be

- Change in the intended use of the structure. E.g. Increased loads etc.
- Changes in seismic zones, prompting seismic retrofitting for critical structures like healthcare facilities, define establishments etc.
- Changes in prevailing codes. E.g. changes in the minimum grade of concrete to be used, for example.
- Additional floors or equipment added to the structure. Change in the intended use of the structure.
- Damage to the structure due to ageing (mostly due to corrosion). E.g. Building and Bridges.

Typical Structural Restoration and Or Strengthening Techniques

It is a general practice to have structural retrofitting to primarily restore or enhance either concrete or steel in the structure. There are primarily the following method used for this purpose.

- **Concrete**
    - Jacketing of beams, columns and increasing slab thickness.
    - Restoration of cover and loose concrete.
- Steel plates to enhance the strength of the structure.
- Footings
    - Extension of footings.
- Steel
    - Replacement of steel
    - Fibre wrapping

FIBER-REINFORCED POLYMER (FRP) COMPOSITE MATERIALS

FIBER-REINFORCED POLYMER (FRP) COMPOSITE MATERIALS provide an outstanding means for rehabilitating and strengthening existing reinforced and prestressed concrete bridges, buildings and other structures.

Whether a structure has been damaged due to overload, earthquake or materials deterioration, or whether the structure requires strengthening to resist increased future live loads, wind, or seismic forces, FRPs provide an efficient, cost- effective, and easy-to-construct means or reinforcing concrete members.

These advanced composites may be designed to act as flexural, shear, and confinement reinforcement. Use of these composites requires less disturbance to building occupancy, bridge traffic, and other functions than rehabilitation that uses additional steel reinforcement.

The concept of strengthening with FRP was pioneered by Professor U. Meier at the Swiss Federal Laboratories for Materials Testing and Research Institute in the early 1980s. His extensive research activities led to the first-time field implementation of FRP rehabilitation for both bridge and building applications. Both the Ibachbridge near Lucerne, Switzerland and the City Hall of Gossau, St.

Gall in northeastern Switzerland was strengthened in 1991 by bonding pultruded carbon-fiber polymer plates to the exterior surfaces of the concrete structures. Details on some of these and other early applications are described in Ref. Since then, there has been keen worldwide interest not only to use polymeric materials in strengthening structures, but also to examine their structural behavior under a variety of loading and environmental conditions.

Reference is a review highlighting some fundamental concepts pertaining to the use of FRP materials in structural rehabilitation; comprehensive expositions of past research activities, test results, and case studies on the same subject are given in a monograph (Ref). To effectively design and execute a rehabilitation scheme.

Figure 3

Seismic Retrofitting

There are four basic types of seismic retrofitting. The most basic is known as “public safety retrofitting.” In this type of seismic retrofitting, a structure is reinforced so that people should not be killed in an earthquake, although they may be injured. In a large earthquake, the structure itself may become unsafe and need to be destroyed and rebuilt. For structures which are not very valuable, this type of seismic retrofitting is a reasonable option, if the company does not want to rebuild the structure altogether.

The next level of seismic retrofitting is “structure survivability,” designed to ensure that the structure will endure the earthquake, although it may need significant repairs. Next comes “primary structure undamaged,” a type of seismic retrofitting in which the majority of the damage to a structure as a result of an earthquake should be cosmetic. Finally, “structure unaffected” is the highest level of seismic retrofitting, chosen for buildings of high economic, social, or cultural value. Some of these terms are a bit misleading, as no structure can be made entirely safe.

Figure 4

A major concern for companies that handle seismic retrofitting is historic buildings. It is important to preserve historic buildings with seismic retrofitting, but it is also important to ensure that the integrity of the building is not compromised. This take extensive work and cooperation with companies which specialize in restoration of historic buildings.

Figure 5

CONCLUSIONS

- Retrofitting reduces the vulnerability of damage of an existing structure during a future earthquake. It aims to strengthen a structure to satisfy the requirements of the current codes for seismic design.
- In this respect, seismic retrofit is beyond conventional repair or even rehabilitation. The principles of seismic retrofit refer to the goals, objectives and steps.
- The steps encompass condition assessment of the structure, evaluation for seismic forces, selection of retrofit strategies and construction.
- The applications include different types of buildings, industrial structures.

REFERENCES

1. 2002, Repair and rehabilitation of structures - Manual, Central public works department, New Delhi.
2. Miss K S. Gaikwad et al Int. Journal of Engineering Research and Applications www.ijera.com ISSN: 2248-9622, Vol. 2, Issue 4 (Version 3), May 2014, pp.25-32
3. Mr. RNS Murthy, International Conference on Information & Engineering Sciences (ISSN-2320-4338), Feb 2013.res, bridges, urban transport structures, marine structures and earth retaining structures.
4. Rodriguez M & Park R. Repair and strengthening of reinforced concrete buildings for earthquake resistance. Earthquake Spectra1991:7(3): 439–459.

5. Sugano S. Seismic strengthening of existing reinforced buildings in Japan. Bulletin of the New Zealand National Society for Earthquake Engineering1981:14(4):209–222.
6. Aguilar J, Juarez H, Ortega R & Iglesias J. The Mexico earthquake of September 19, 1985. Statistics of damage and retrofitting techniques in reinforced concrete buildings affected by the 1985 earthquake. Earthquake Spectra1989:5(1):145–151.