

Impact of Professor Urs Meier in application of CFRP composites in structural strengthening in Iran.

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ABSTRACT: Before 2003, only a limited number of civil engineers were familiar with Fiber Reinforced Polymer (FRP) composite's potential in structural rehabilitation in Iran. At that time, only a couple of buildings were strengthened by means of this technology. Nevertheless, during the last decade, considerable amount of CFRP composites has been incorporated into strengthening several projects of bridges and buildings in Iran.

Knowing the fact that Iran could be a rising market for CFRP composites, Professor Urs Meier was invited to Iran in 2003 to present this new method to the local engineers. He was also invited to visit different Seismic Retrofitting projects in Tehran as well as giving lectures in scientific conferences. His lectures in different conferences and workshops raised curiosity of Iranian researchers and experts about this innovative method for structural strengthening. As one of the results of his efforts, nowadays a big number of Iranian structural engineers are familiar with CFRP in structural rehabilitation and have confidence in using this method in the projects. For the time being, Iran has one of the largest number of CFRP strengthened structures in the world. In this paper, we are trying to present Professor Urs Meier's impact on Iranian engineering society that led to the current state of this technology in Iran.

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1 FOREWORD

Experienced severe earthquakes during the past decades, there was a growing demand for new technologies and methods in structural strengthening in Iran. Restoration of historical monuments and buildings required new methods compared to existing traditional methods (such as externally bonded steel plates, steel and concrete jackets, adding extra elements to structure, etc.). Application of externally bonded FRP composites was a clever solution regarding its high strength to thickness and weight ratio, which in 2003 was introduced in Iran by Prof. Masoud Motavalli (current head of Structural Engineering Research Labs at Empa).

In 2004, Professor Urs Meier visited Iran and introduced FRP composites to local engineers, practitioners, owners and building officials. During his lectures on FRP composites in different seminars, he introduced advantages of using FRP composites such as; durability, high tensile strength, low weight, low thickness, high fatigue and corrosion resistance. He also emphasized that FRP composites are special solutions for special structural problems, but not solution for all of them. “Do not expect a Miracle” was titled by a national newspaper as the main point of interview with Professor Urs Meier (see Figure 1). Binding an MoU between EMPA (Switzerland) and University of Tehran (Iran) was one of the results of Professor Meier’s visit to Tehran in 2004, in which EMPA pledged to send a lecturer to University of Tehran to teach “Applications of Polymer Composites in Civil Engineering” to master and PhD students. This course has been taught for 13 years, and more than 400 students finished this course by the end of 2016. Alongside with University of Tehran, other universities in Iran started to teach this course and every year a considerable number of students get familiar with FRP composites consequently.



Figure 1: Professor Urs Meier in the seminars held in Iran

Professor Meier rewarded Mirko-Roš-Award to a team of talented students of University of Tehran, as the winners of ACI’s competition (see Figure 2).

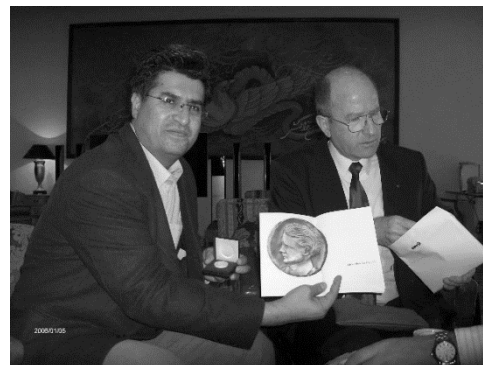
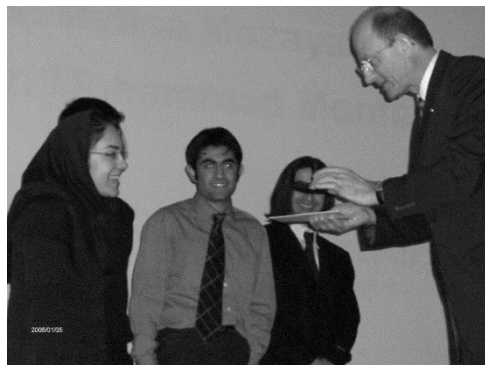


Figure 2: Mikko Roš awards 2005

He also visited a couple of Iranian monuments and historical buildings in Tehran to give advice on feasibility of using FRP composites in their strengthening concept. (See Figure 3, Figure 4)



Figure 3: Dr. Shari'ati Museum, during strengthening (left), front entrance of the Museum (Right)



Figure 4: Iranian foreign ministry's main building, which was founded during Pahlavi dynasty.

These events had significant impact on Iranian construction society, making them interested in using FRP materials for strengthening projects. Again in 2006 Prof. Meier was invited to visit Iran. He visited a couple of strengthening projects applying FRP composites. Very precious technical notes about FRP installation was collected from his advices, which still are being used in current projects. (See Figure 5)

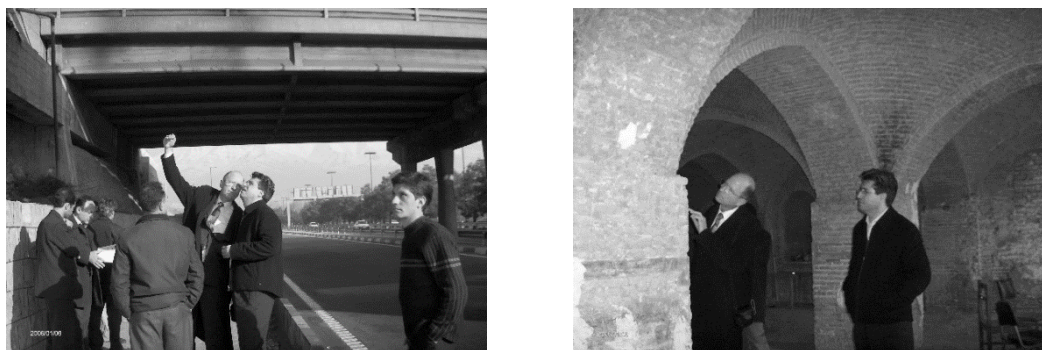


Figure 5: Hemmat Bridge (left), Ghazaghkhane (a military center) which were founded during Qajar dynasty(Right)

2 PROFESSOR URS MEIER'S IMPACT ON IRAN CONSTRUCTION INDUSTRY

As described in previous section, Professor Meier's visits developed a new trend in strengthening methods for existing structures in Iran and expanded FRP's application in construction industry. Due to lack of local codes, application of FRP composites was limited to a few special projects before 2004. In 2004, Professor Meier's role in introducing FRP materials was really impressive. Local design codes and guidelines were developed, such as "Manual No.345 of Iranian Management and Planning Organization", to provide engineers with mandatory documents for design and application details of FRP composites. These all led to a significant increase in FRP composites demand and number of the strengthening projects using FRP composites in Iran started increasing significantly. For example in Radyab Co. (Iran), we have completed several projects of different types (i.e. buildings, bridges ...) since 2004.

During the past decade, several companies has started applying FRP composites in structural strengthening projects. Following projects are only a part of several projects completed by one of these companies, i.e., Radyab Co. (www.radyab.co) in Iran.

2.1 Seismic Retrofitting of Parsian Azadi Grand Hotel, Tehran, Iran

Parsian Azadi Grand Hotel, a 35 year old 28 story building with about 500 rooms was one of the largest hotels in Tehran in 2005. Structure of this hotel was designed and constructed before the publication of modern seismic codes lacking sufficient strength against lateral seismic loads. The structure had two major deficiencies: 1. Insufficient transverse reinforcement in columns and 2. Soft story at ground floor (lobby) with 10.5 meter height (M.Motavalli and J. Najafi 2008).

To overcome the first problem, columns were wrapped by means of Carbon Fiber Reinforced Polymer (CFRP) fabrics (Figure 6). To overcome the soft story problem and also to reduce the building drifts, steel bracings along with hydraulic dampers were added to the structure.

Design and consultancy of this project was undertaken by SMteam GmbH (Switzerland) and all the tests for quality control of the CFRP (laboratory and in-situ tests) were conducted by EMPA (see Figure 7).



Figure 6: Hotel Parsian Azadi, Confining Columns using CFRP sheets



Figure 7: Hotel Parsian Azadi, in situ tests for CFRP installation quality control (Left), laboratory tests at EMPA for material quality assurance (Right)

2.2 Ehsan Subway Station, Shiraz, Iran

The roof slab of subway station located in Ehsan Square in Shiraz is under constant heavy traffic loads and due to the request of employers, the bearing capacity of roof slabs was to be increased. The improvement in load bearing capacity of slabs was achieved by applying CFRP Laminates of 5 cm width (see Figure 8) and also by increasing the bending moment capacity of roof beams with the help of 5 CFRP Laminate strips each of 10 cm width. The roof beams were also retrofitted for shear stresses by applying CFRP wraps accordingly.

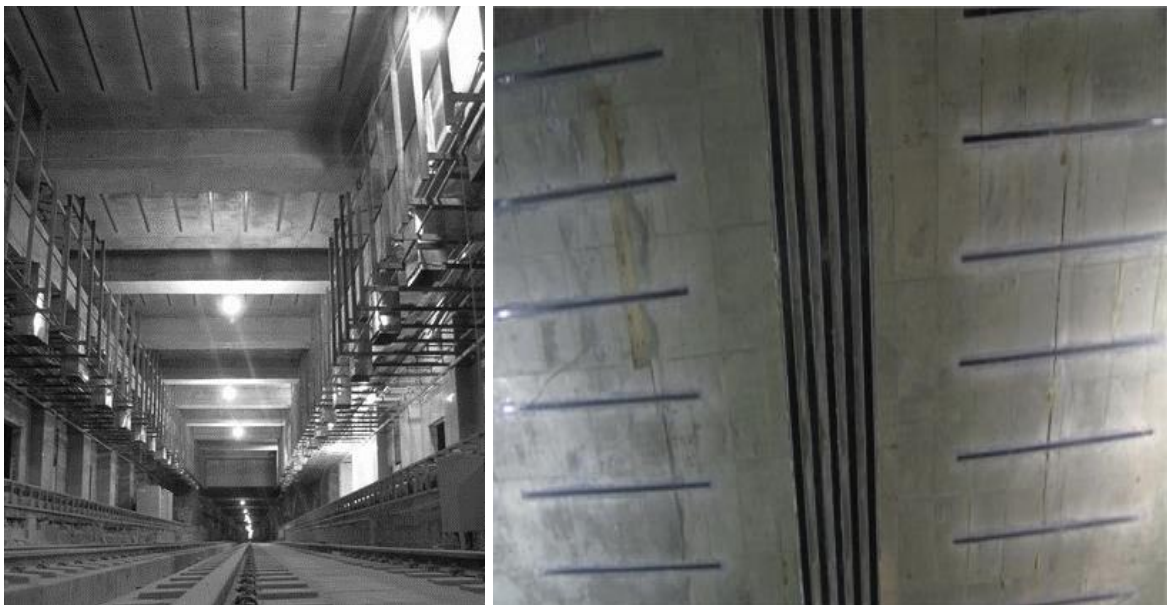


Figure 8: Ehsan Subway Station, Beams and slabs are strengthened using CFRP laminates

2.3 Qomrud Bridge, Qom, Iran

An RC bridge was constructed on the Qomrud River. Concurrent with the implementation of the project, due to changes in the loading, it was decided to strengthen the bridge main beams for bending. According to the retrofitting plan, the main beams were strengthened using CFRP Laminate. (See Figure 9)



Figure 9: Qomrud Bridge, Concrete beams are strengthened using CFRP laminates

2.4 Cement Factory Silos, Abadeh, Iran

Abadeh cement factory has nine concrete silos and several industrial structures which have been worn out after 35 years of continuous operation and loading. Analysis by the consultant engineer showed that if the structures were to continue their operation with existing conditions, they have to be replaced after a few years. To overcome this problem, CFRP fabrics were applied to the structure in two perpendicular directions (Figure 10).



Figure 10: RC silos are strengthened using CFRP sheets in two perpendicular directions

2.5 Seismic Retrofitting Dr. Shari'ati Museum, Tehran, Iran

Dr. Ali Shari'ati's residence in Tehran was converted to museum and cultural center by Tehran Municipality. The structure was unreinforced masonry building with load bearing masonry walls. The main problem in this building was inadequacy of lateral load bearing elements. In order to overcome this problem, shear walls were constructed in one lateral direction and in the other direction the brick walls were strengthened by CFRP laminate.

Study and consultancy of this project was undertaken by SMteam GmbH (Switzerland- see Figure 11).

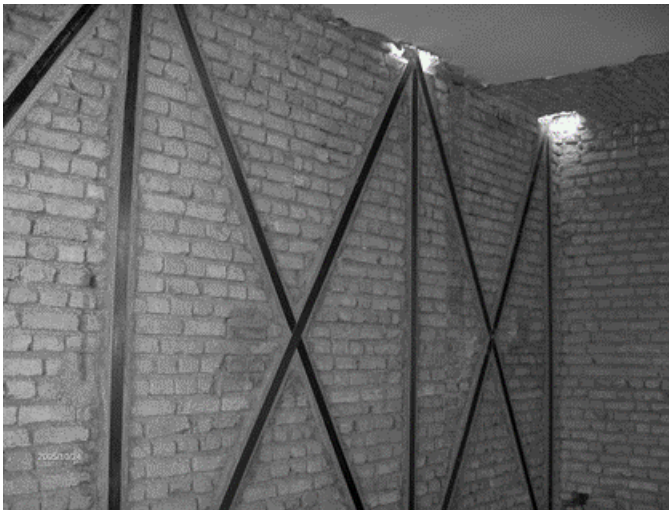


Figure 11: Dr. Shari'ati Museum, masonry walls are strengthened with CFRP laminates to increase to lateral strength

3 CONCLUSION

As we described, application of FRP composites in Iran was introduced by Professor Urs Meier in the right time and at the right place, so in many projects FRP composites are being used consequently.

4 REFERENCES

- Shirazi, P., and Safavi, B. (2005, September 03). FRP as a method of strengthening for historical buildings- Do not expect a Miracle (in Persian). Jaam-e Jam (newspaper), pp. 10.
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