

# Seismic strengthening of the old high rise buildings, case study

**Ali Ranjbar<sup>1</sup>**

**Civil Engineer, Reinforcement Project of Azadi Grand Hotel, Tehran**

Email: alira730@yahoo.com

## **Abstract**

Old high rise buildings such as hotels lack a continuous resistance system against lateral forces due to architectural limitations. This usually results in forming a soft story in the ground floor, which is not safe according to the latest version of earthquake design code. The importance of these buildings and also being located in a high risk earthquake zone in Iran necessitate strengthening of these soft stories against earthquake. In this paper different methods such as reinforcement of columns and shear walls by carbon fibers, and adding coupled steel bracings with viscose dampers are discussed. The design criteria and construction techniques of an actual case which has been applied in a hotel in Tehran for the first time is also presented.

**Keywords: Soft story, Strengthening, Viscose damper, Carbon fiber**

## **INTRODUCTION**

Earthquake design codes are subjected to modification and revision with the advance in seismic science and our knowledge about earthquake. Due to these, the fourth edition of the Iranian earthquake design code 2800 is being prepared in our country. Meanwhile, if most of the old buildings are reassessed on the basis of these codes; they are found to be of low resistance against earthquakes and must be strengthened. This is in high priority for old buildings such as hotels which are categorized as important buildings. In this article, technical and construction aspects of strengthening method which was applied in Azadi grand hotel in Tehran will be briefly described.

By investigating the as-built drawings, making observations, and performing necessary tests on the structure of the Azadi Hotel, it was known that due to the removal of shear walls in the lobby of the hotel for architectural needs, the lateral loads at this floor are exerted on the foundation mainly by columns. As a result a soft story has been formed relative to upper stories. Also low compressive strength of the concrete of columns and the outstandingly deficient number of stirrups was observed especially at joints. By evaluating the amount of drift, and comparing it with the limits permitted by the design codes, it was known that the structure of the building in the ground floor and basements was weak against lateral forces, hence building strengthening is necessary.

In view of this, different strengthening methods was considered and finally reinforcement of columns and shear walls by carbon fibers, and adding coupled steel bracings with viscose dampers were selected and recommended. The pertinent design and construction procedure is explained in the following section.

## **1. SEISMIC STRENGTHENING METHOD - REINFORCEMENT BY POLYMER FIBERS**

This work was done through wrapping multiple sheets of Carbon Fiber Reinforce Polymer (CFRP) round the surface of columns and shear walls by means of especial adhesives such as Sika Wrap 201C or Sika Wrap 300C. This protection not only enhances the shear strength of columns and shear walls, but also builds up the axial bearing capacity of columns due to their confinement.

Also, if this method is employed in reinforced concrete beams, their bending strength and their ductility are increased, and this causes the beams to undergo failure under higher ultimate loads.

---

<sup>1</sup> - B.Sc. in Civil Engineering from Tabriz University in 1999.