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**"Research Note"**

# A NEW STRONG FLOOR-REACTION WALL SYSTEM WITHOUT GALLERY FOR EXPERIMENTAL STUDIES IN STRUCTURAL MECHANICS*

H. KAPLAN[1], H. GÖNEN[2], H. NOHUTCU[3], N. ÇETINKAYA[1] AND S. YILMAZ[1]**

[1]Dept. of Civil Engineering, Pamukkale University, Denizli, Turkey
[2]Dept. of Civil Engineering, Eskisehir Osmangazi University, Eskisehir, Turkey
[3]Dept. of Civil Engineering, Celal Bayar University, Manisa, Turkey
Email: syilmaz@pau.edu.tr

**Abstract–** Strong floors and reaction walls are important elements of structural mechanics laboratories. They should be designed before the construction of the laboratory building for efficiency. They have a gallery used for the anchorage of the test models and storage of test equipment. In this paper, a strong floor without a gallery has been designed for an existing laboratory facility. The anchorage system has been designed to fix the model structures to the strong floor. Design issues of strong floor and reaction floor systems are mentioned in the scope of the paper. The construction of the system is simple and economical and provides a comfortable environment for experimental studies.

**Keywords–** Strong floor without gallery; reaction wall; structural mechanics laboratory; locking anchorage system

## 1. INTRODUCTION

In structural mechanics, experimental studies are very important because of uncertainties affecting structural behavior. Although tests on simple models can be carried out in simple systems [1, 2], many experimental studies require strong floor – reaction wall (SFRW) systems because of the dimensions of experimental models in structural engineering [3]. In a typical test, model structures are fixed to the strong floor and the load is applied by a loading system erected on the reaction wall.

Although small SFRW systems exist in many laboratories at the moment, many other laboratories have no such system. Therefore, constructing larger SFRW systems for those laboratories is a necessity to. However, it is difficult to construct a conventional strong floor system with a gallery inside an existing building. This difficulty forces researchers to modernize their laboratories with different systems. Strong floors without a gallery is an ideal solution for such modernization works in existing labratories.

This paper deals with the design and construction of a new SFRW without a gallery in an existing building. The pros and cons of the proposed SFRW system in terms of performance, operation and construction are discussed. Also, a locking anchorage system has been developed to connect the model to the new strong floor system. Design issues related to the SFRW and locking anchorage system is also explained in the paper.

## 2. SFRW SYSTEM WITHOUT GALLERY

As a result of recent devastating earthquakes, many research projects on the subject have become important to ensure the safety of the public. A large scale SFRW system became a necessity in the

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**Corresponding author

Pamukkale University Structural Mechanics Laboratory for implementing tests on three-dimensional model structures to investigate their seismic behavior. It was necessary to find a new solution to overcome the risks of damage to the laboratory building due to deep excavation for the gallery to be constructed under the strong floor. Therefore, the research team designed a new SFRW system of 183 $m^2$ area without a gallery. The general view and the dimensions of the new system are shown in Fig. 1.

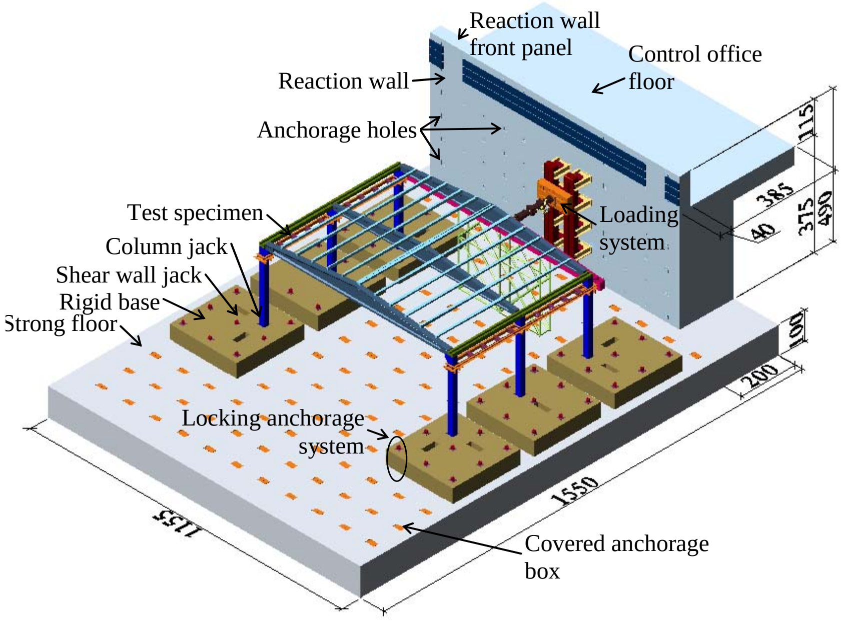


Fig. 1. Elements and dimensions of the SFRW system. (dimensions in cm)

Strong floor of the system is composed of 3 layers. There is a 0.2 m thick filter layer for the water drainage at the bottom as the lowest layer. The second layer is a 0.2 m thick layer with 20 Mpa concrete compressive strength. The top layer is 0.6 m thick reinforced concrete having 50 MPa compressive strength.

The reaction wall is 5 meters in height, 11 meters in length and 2 meters in depth. There is a reinforced concrete slab of 0.15 m thickness on the wall. Technical control rooms have been constructed over this slab. Anchor holes are placed at 0.75 m distances at horizontal and vertical directions over the whole front panel of the reaction wall. After completing the rebar works of the strong floor, special anchor boxes were erected precisely among the rebars. Concreting was done with a high strength (50 MPa) and high slump (20 cm) concrete. The construction stages of the new SFRW system are shown in Fig. 2. The final photograph of the system taken during an experiment is shown in Fig. 3.

## 3. ANCHORAGE SYSTEM

A new user friendly anchorage system has been developed to fix test models to the strong floor. This anchorage system is also suitable for conventional strong floors with gallery and requires less workmanship for fixing the model to SFRW.

A total of 143 anchor boxes have been placed at 100 cm spacing in each direction throughout the strong floor. The anchorage system is composed of an anchor box, a locking apparatus and a covering steel plate. Anchor boxes are 60 cm in height and made of three parts, bottom, top and cover parts (Figure 4). Two steel rods of 10x10x10 mm dimensions are welded to the top face of the boom part of the box to align the head of the locker rod. A 20 mm-diameter hole is opened at the bottom for drainage. The details of the anchor box and its usage are shown in Fig. 4. The locking stud is designed to fix the model structures to the strong floor. It is composed of two pieces of I100 steel profiles and a 30 mm diameter steel rod and nuts.


Fig. 2. Some of the construction stages of SFRW system

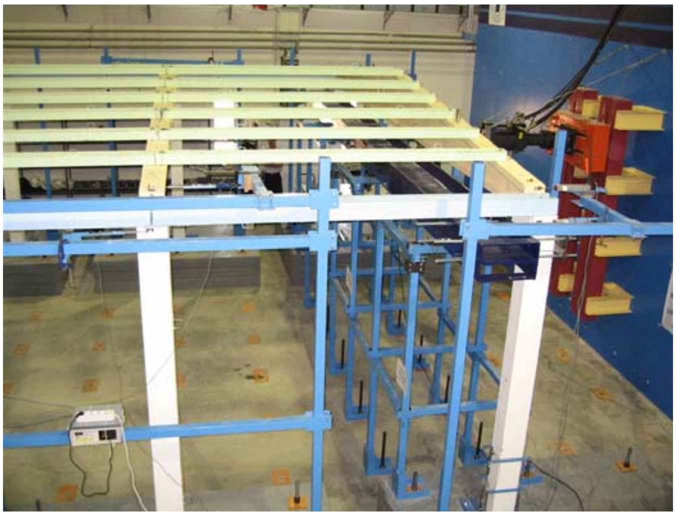

Fig. 3. View of completed SFRW system during an experiment

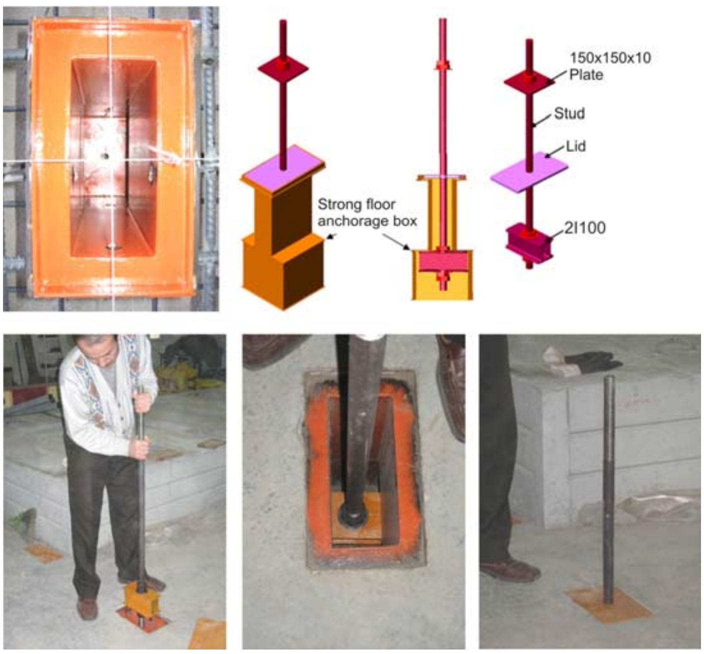


Fig. 4. Details and usage of the anchorage system

## 4. DESIGN ISSUES

The design and detailing of the SFRW system is based on the capacity of the actuators in the laboratory. A unit strip of the SFRW system is designed to bear against the load capacity of two actuators, which are readily available in the laboratory. This is to provide necessary flexural and shear capacity to the SFRW elements. Besides, anchor boxes and locking apparatus are designed to resist forces transmitted through the test specimens. All types of loads (axial, shear and flexural) are to be transformed into shear and axial forces at critical sections of the system. The most important failure mode for the strong floor is local compression failure around anchor boxes near the surface of the strong floor. This compression is caused by the shear forces in the locking apparatus. To prevent compression failure, the side surface area of the covering lid was chosen such that the bearing concrete area has enough capacity. Taking the design loads into consideration, a minimum of four boxes are required to fix specimens at ultimate capacity of the actuators to ensure shear safety. On the other hand, flexural forces in specimens are transformed into axial forces in locking stud and shear forces in 2I100 profiles used for locking. These elements are also designed to carry corresponding forces. The last check is the punching safety around the boxes. Punching might be caused by axial forces in locking studs. For this check, the distance between the top of the floor and the level where the box is expanded in the concrete should be considered. Pull-out of the box is out of scope as it cannot happen without punching failure.

## 5. CONCLUSION

A SFRW system without gallery is designed for an existing laboratory and constructed in place. The developed SFRW system can be constructed in the existing laboratories safely. The SFRW system is tested in many experiments and performs successfully. Even the design forces were realized in some experiments and no failures were observed in the system.

A new locking anchorage system has also been developed to connect the model structures to the new strong floor without gallery. The efficiency of the locking anchorage system has been proved during many experiments. The design of the system is completely based on the actuator capacity of the laboratory with some factor of safety.

The new system is not tested for ultimate dynamic loadings. However, some sample cyclic dynamic tests of low load levels with a loading frequency of 10 Hz were carried out and no failures were observed.

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