Outline of 3Q Series and Introduction of Projects Using 3Q Series

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Summary

The existing buildings with a low performance of seismic resistance are likely to be severely damaged in case of big earthquakes. To save the lives and properties in these buildings, seismic retrofitting is obligatory on the owners of the buildings and the society. The retrofitting of a building usually involves noise, vibration and dust during the work which means the occupants are unable to stay in the building and are required to relocate. It has been a major reason to dissuade building owners from retrofitting the buildings. This paper introduces a series of retrofitting techniques called 3Q series. 3Q series minimise the impacts on occupants and allows retrofitting without relocation of occupants. This paper also introduces some retrofitting projects using 3Q series including the retrofitting of some historically valuable buildings.

Keywords: earthquakes; retrofitting; noise; vibration; dust; 3Q series

1. Introduction

There are recently large needs for the retrofitting of buildings while keeping the buildings on operation. It is therefore necessary to minimise the interference on building users while the retrofitting is conducted. 3Q series realise the above requirement by eliminating the work involves concrete casting, welding, anchorage, etc., which have the risks of noise, vibration and fire, as much as they can. Techniques of 3Q series use compact components to assemble retrofitting structures. This allows the work to be conducted in a small area, minimising the interference on the building users. 3Q represents Quiet, Quick and high-Quality. Techniques of 3Q series involve all the three Q's in an elegant manner to realise the retrofitting of buildings, which can remain fully operational during the retrofitting.

2. Techniques of 3Q series

There are four techniques of 3Q series, namely 3Q-Wall, 3Q-Column, 3Q-Brace and 3Q-Joint.

In 3Q-Wall, PCa blocks and/ or FRP blocks, which are compact and light-weight, are used to construct new shear walls, to strengthen existing shear walls and to infill opens of existing wall to make it shear wall (Fig. 1). FRP blocks are made of glass fibre-reinforced plastic and have a latticed geometry keeping translucency and ventilation through the shear walls.

In 3Q-Column, compact and light-weight steel panels are assembled mechanically to reinforce existing columns by steel plate jacketing (Fig. 2).

In 3Q-Brace, divided steel tubes are used to create a steel brace system within an existing frame (Fig.3). Steel tubes work as restrainers realising braces with high ductility.

3Q-Joint is to improve the shear strength of a joint between an existing frame and a retrofitting structure. The concrete surface of an existing frame is consistently roughened using a water-jet, and the roughness is measured and controlled by a laser. This enables to include the shear strength of the rough concrete surface in a calculation of the joint strength.

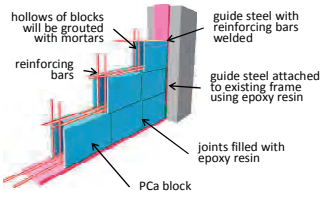

Fig. 1: 3Q-Wall

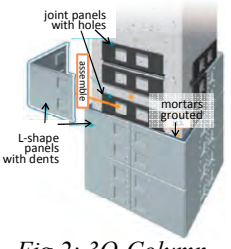

Fig.2: 3Q-Column

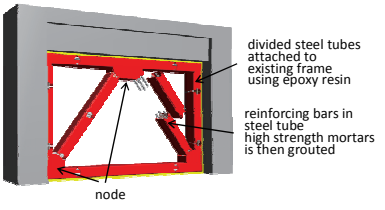

Fig.3: 3Q-Brace

3. Introduction of retrofitting project using 3Q series

3.1 Ikeda City Hall (Osaka) (Fig.4)

This project was to retrofit a government office, which was built in 1973. Retrofitting was planned as to enable the normal operation of the building during the retrofitting, and to maintain the exterior and facility of the building.

3Q-Wall, 3Q-Brace and 3Q-Column were used to minimise the noise and vibration of retrofitting work during the operating hour and also to minimise the space used for the retrofitting work not to interfere the operation of the building.

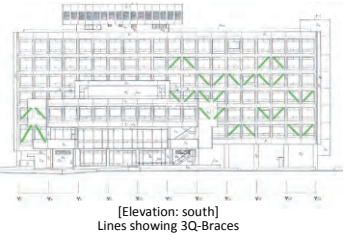

Fig.4: Ikeda City Hall

3.2 Kobe Shosen Mitsui Building (Hyogo) (Fig.5)

Kobe Shosen Mitsui Building was built in 1922 with American-renaissance style. The exterior and interior of the building was conserved and the operation of the building was maintained during the retrofitting. There are about 60 tenants of retailers and offices in Kobe Shosen Mitsui Building.

Seismic resistant steel frame with braces was built on a courtyard, which is a blind spot from outside of the building, and linked to the existing frame to carry the seismic load. To resist the large shear force, between the steel frame and the existing frame, 3Q-Joint was used to achieve the high shear strength of the joints.

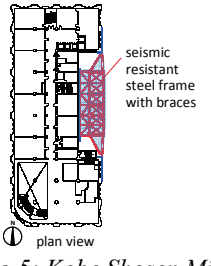

Fig.5: Kobe Shosen Mitsui Building

3.3 The Museum Yamato Bunkakan (Nara) (Fig.6)

The museum Yamato Bunkakan, built in 1960, is a master piece of Isoya Yoshida, holding the unique amalgamation of modern architecture and traditional Japanese-style design, such as Namako-wall. The retrofitting was planned to maintain the exterior and interior of the building as it was 50 years ago.

During the retrofitting, some of the collections and documents were stored in the storehouse and the operation of the museum was maintained. As a museum, vibration, dust and noise were not acceptable and as measures against the above, 3Q-Wall and 3Q-Brace were used in the retrofitting.

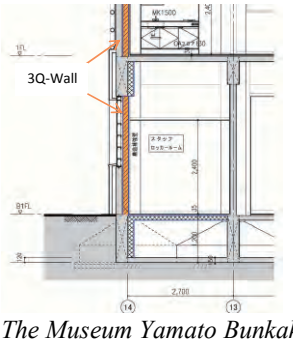

Fig.6: The Museum Yamato Bunkakan

4. Conclusion

In order to retrofit the buildings while remaining the buildings fully operational, the retrofitting techniques, which use high strength and compact components, are one of the elegant solutions to the obstacles of the retrofitting. There will be more demands for the retrofitting of buildings in coming future. Development of retrofitting techniques which have minimum impacts on building users and enable to remain the building fully operational, is further required.