Structural Design of Office Building Using Seismic Suppression System with Monitor

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Summary

Modern buildings are expected to meet a diverse range of performance requirements, with safety, security, environmental considerations, long-life and planning flexibility all regarded as important. A new seismic response control system called "TASMO" (for TAisei Smart suppression system with MOnitor) has been developed to deliver such performance improvements. The structural elements that absorb seismic energy are completely separated from the parts supporting the vertical load. Steel dampers and oil dampers are incorporated as energy-dissipating seismic response control devices that, in the case of an earthquake, absorb the seismic energy. Excellent seismic performance is obtained while a new type of architectural framework is realized as well.

This paper gives an outline of this new system, describes its application to an office building and explains the structural design, in which the building's structural system is designed to harmonize with the architectural external walls. By adopting pre-stressed concrete technology to complement the new response control system, open office spaces without columns are achieved. Further, a monitoring system is provided to allow for checking of the energy dissipation devices and the building as a whole from a distance. The result is an office building that offers a long lifetime with flexible space utilization.

Keywords: Seismic suppression system; Pre-cast pre-stressed concrete beam; Monitoring system; Long-life office

1. Application of new seismic suppression system to office building

Figure 2 is an outline of this new seismic suppression system. The connecting beams are arranged between the wall-columns. These beams use low-yield steel for the central web panel and are a type of steel hysteretic damper. The wall-columns are connected to the foundation with pin joints and there are also oil dampers at the bottom of the wall-columns. With this system, the greater part of the seismic force is absorbed by these energy-dissipation devices.

Here, the application of the new seismic suppression system to an office building is reported (see Fig. 3). The new seismic suppression system was installed in this building, with the exterior walls acting as wall-columns. Steel beams connect adjacent wall-columns at floor level (see Fig. 6). Low-yield steel (LY100) is used for the central web panels of these beams. These central parts of the connecting beams are fixed to the steel brackets with bolts, so they are easily replaceable. It is only these parts that need to be replaced after several severe earthquakes have been experienced, so it can be said that this system yields a sustainable structure with a long life. Further, to secure the redundancy and the robustness, elastic beams are used at the roof level. As a result, even when all the connecting beams yield, elastic behavior is expected as the entire building. The wall-columns around the circumference of the building are connected to the foundation with pin-joints so that the steel dampers absorb energy efficiently. The wall-column width decreases downward from the mid-point of the second floor in proportion to the building's bending moment distribution during an

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earthquake. There are a total of eight oil dampers at the bottom of the wall-columns in the transverse direction.

Figure 9 shows the maximum responses obtained in the dynamic analysis with Level 2 acceleration inputs. The maximum response of story drift angle is less than 0.01, which is the design criterion. The maximum acceleration response is less than the maximum acceleration of the input waves, so it can be said that this system acts properly and controls the amplification of acceleration.

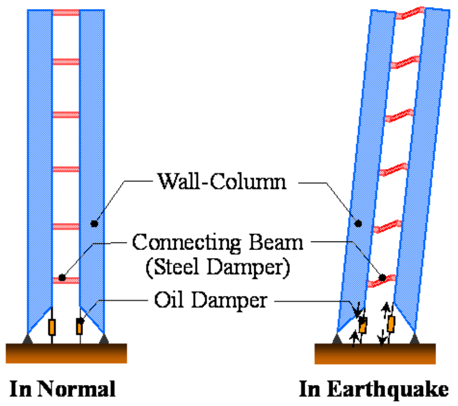

Fig.2: Frame of seismic suppression system

Fig.3: View of building

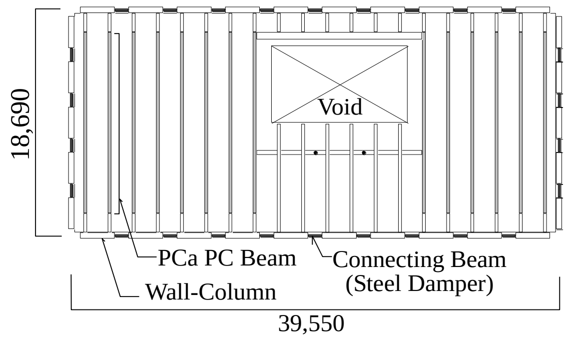

Fig.6: Framing plan

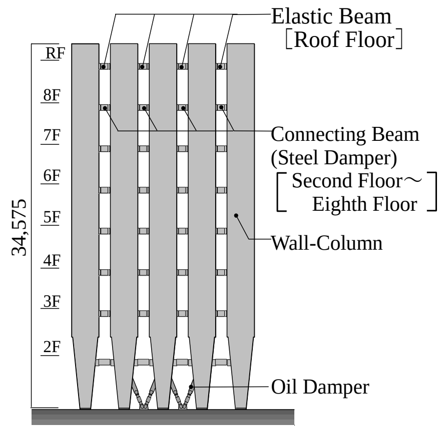

Fig.7: Framing elevation

2. Conclusion

A new type of seismic suppression system has been developed and applied to an office building with 8 above-ground stories. In this system, effective use is made of both steel dampers and oil dampers to obtain excellent seismic performance.

In addition, pre-stressed concrete technology was adopted to attain 19-m-spans that would allow column-free office space inside.

A monitoring system is provided for the building, with the acceleration of each floor and the strain of the steel dampers being recorded at all times. These values can be monitored and analyzed and the soundness of the steel dampers and the whole building can be observed from a distant location.

The result is an office building that offers a long lifetime with flexible space utilization.

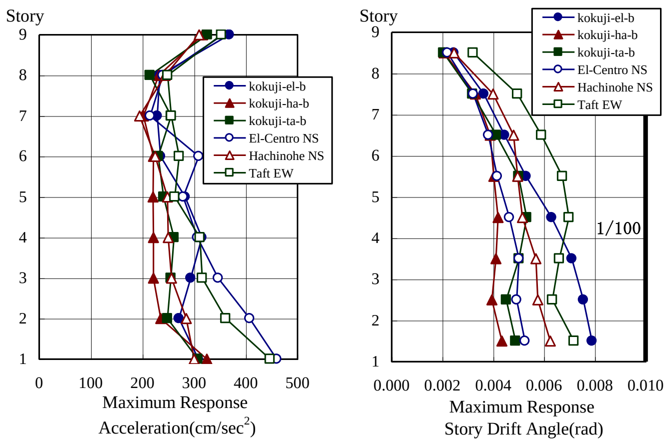

Fig.9: Results of dynamic analysis (transverse direction)