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Earthquake Retrofit of Large Panel Buildings by Basement Isolation

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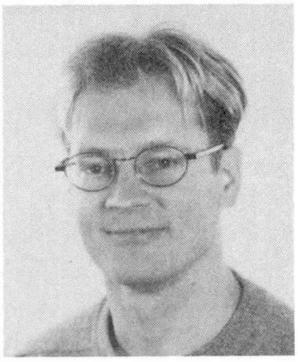

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SUMMARY

Hysteretic device systems are known to provide very economical earthquake retrofitting solutions for non-ductile frames. Using this concept to retrofit large panel buildings, a "basement isolation" system emerges that can be implemented with very little disturbance of the tenants. This paper focuses on the structural realization and detailing of such systems. The problem of redistribution of vertical loads caused by the change in system is addressed and implementation details for the main system components, the seismic links and hysteretic devices, are discussed. It is concluded that this concept provides for very economical earthquake retrofitting solutions for LPBs.

1. Structural Concept of Hysteretic Device Systems

Hysteretic device systems (Dorka 1994) have three main structural features: A stiff primary horizontal load resisting system (PHS) with seismic links (SLs) and a soft secondary horizontal load resisting system (SHS) acting parallel to the PHS. The purpose of the PHS is to concentrate the horizontal deformations in the seismic links where hysteretic devices (Hydes) are placed. Such devices must be stiff and provide a stable elasto-plastic hysteresis loop. Thus, the horizontal forces in the PHS are limited to the maximum hysteretic device forces. Because of the large stiffness, the Hydes are activated at small displacements dissipating most of the earthquake's input energy (up to 85%). This in turn keeps overall horizontal displacements small. The SHS provides stability to the building during the mostly non-linear behavior of the PHS under severe earthquake loading. Well designed hysteretic device systems can have forces known only from very ductile systems and displacements known only from very stiff systems thus combining the advantages of both traditional structural approaches.

2. "Basement Isolation" for Retrofitting LPBs

Large panel prefabricated buildings (LPBs) are very stiff by nature. Introducing only one seismic link in the basement produces a hysteretic device system which can be appropriately termed a "basement isolation" system. For this, all transverse walls in the basement must be cut free so that all horizontal forces are transmitted through the remaining walls with the seismic links (fig 1). A reliability study of a 6 story basement isolated LPB based on 500 generated earthquakes (Dorka, Ji, & Dimova 1997) yielded the design curve for the device forces (fig 2).

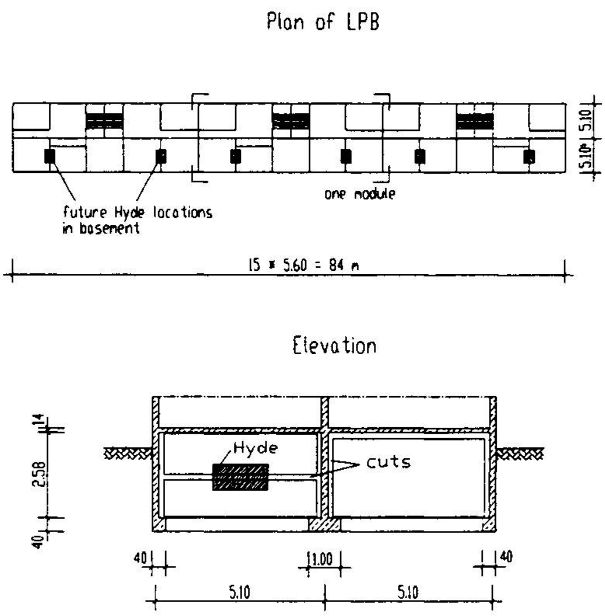

Fig1: Plan and basement elevation of a typical 6 story LPB with possible Hyde locations.

2. Design and Detailing of a Basement Isolated LPB

The most severe change to the existing system is the cutting or removal of the transverse basement walls. Ground floor walls and panel connections are in general able to redistribute the loads but the fundations usually need strengthening. The elastic rotational capacity of the basement wall connections defines the limit to the allowable drift and provides the design point in fig 2. Three devices may be used as Hydes that are simple to manufacture and implement: Shear panels, Honeycomb and friction plate. The least expensive should be the Honeycomb, followed by the friction plate. Shear panels cause the highest manufacturing and implementation effort of these three.

3. Conclusions

Basement isolation can dramatically enhance the performance of LPBs under earthquakes. Simple devices based on yielding or friction are available for the required performance range. Care must be taken to secure redistribution of vertical loads due to the change in system. Due to the limited interference in the existing structure and undisturbed usage of the building during retrofitting, this concept should be economically far superior over conventional retrofitting schemes.

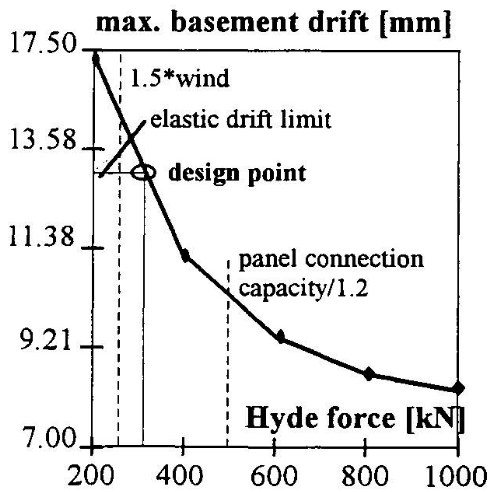

Fig 2: Design curve for Hyde forces in a 6 story LPB under Kalamata

3. References

Dorka, U.E. 1994. Hysteretic device systems for earthquake protection of buildings. *5th US NCEE.* Chicago. 1: 775-785.

Dorka, U.E.; Ji, A & Dimova, S. 1997. Earthquake safety of large panel buildings retrofitted with hysteretic devices. *ICOSSAR '97.* Kyoto.