World Academy of Science, Engineering and Technology
International Journal of Civil and Architectural Engineering
Vol:9, No:04, 2015

Building Exoskeletons for Seismic Retrofitting

Authors : Giuliana Scuderi, Patrick Teuffel

Abstract : The proven vulnerability of the existing social housing building heritage to natural or induced earthquakes requires the development of new design concepts and conceptual method to preserve materials and object, at the same time providing new performances. An integrate intervention between civil engineering, building physics and architecture can convert the social housing districts from a critical part of the city to a strategic resource of revitalization. Referring to bio-mimicry principles the present research proposes a taxonomy with the exoskeleton of the insect, an external, light and resistant armour whose role is to protect the internal organs from external potentially dangerous inputs. In the same way, a "building exoskeleton", acting from the outside of the building as an enclosing cage, can restore, protect and support the existing building, assuming a complex set of roles, from the structural to the thermal, from the aesthetical to the functional. This study evaluates the structural efficiency of shape memory alloys devices (SMADs) connecting the "building exoskeleton" with the existing structure to rehabilitate, in order to prevent the out-of-plane collapse of walls and for the passive dissipation of the seismic energy, with a calibrated operability in relation to the intensity of the horizontal loads. The two case studies of a masonry structure and of a masonry structure with concrete frame are considered, and for each case, a theoretical social housing building is exposed to earthquake forces, to evaluate its structural response with or without SMADs. The two typologies are modelled with the finite element program SAP2000, and they are respectively defined through a "frame model" and a "diagonal strut model". In the same software two types of SMADs, called the 00-10 SMAD and the 05-10 SMAD are defined, and non-linear static and dynamic analyses, namely push over analysis and time history analysis, are performed to evaluate the seismic response of the building. The effectiveness of the devices in limiting the control joint displacements resulted higher in one direction, leading to the consideration of a possible calibrated use of the devices in the different walls of the building. The results show also a higher efficiency of the 00-10 SMADs in controlling the interstory drift, but at the same time the necessity to improve the hysteretic behaviour, to maximise the passive dissipation of the seismic energy.

Keywords : adaptive structure, biomimetic design, building exoskeleton, social housing, structural envelope, structural retrofitting
Conference Title : ICABE 2015 : International Conference on Architectural and Building Engineering
Conference Location : Venice, Italy
Conference Dates : April 13-14, 2015