OPTIMUM LOCATION AND PROPERTY OF STIFFENED STOREY IN SHEAR FRAME STRUCTURES SUBJECTED TO SEISMIC LOADING

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The moment frame is a suitable case as lateral bearing system for tall buildings. While sufficient resistant and ductility can be provide by the moment frames, but the lateral displacements and storey drifts, in much cases, do not satisfy the code requirements during lateral loading. To overcome this deficiency, use of outriggers is an appropriate selection to increase lateral stiffness without paying a high premium in steel tonnage. In the outrigger system, the axial stiffness of the peripheral columns is invoked for increasing the resistance to overturning moments. This efficient structural form consists of a central core, comprising either braced frames or shear walls, with horizontal cantilever trusses or girders known as outrigger trusses, connecting the core to the outer columns. Also to mobilize other peripheral columns, in addition to those at the end of outriggers, and assist in restraining the outriggers, a belt truss is usually used around the structure at the levels of the outriggers (Raj Kiran Nanduri, 2013). The optimum location of single or multi outriggers and various types of outriggers in steel or concrete structures are investigated by some researchers (Moudarres, 1984; Coull and Lau, 1989; Kian and Siahaan, 2001; Bayati et al., 2008; Gerasimidis et al., 2009; Herath et al., 2009). The stiffened storey concept, introduced in this paper, derives from the outrigger and belt truss system but no central core is considered. In the other words, the moment frames at one storey are stiffened locally by some lateral stiffening tools such as braces or shear walls.

In the current work, the effectiveness of the stiffened storey system in 2-D shear frames against the seismic loading are investigated. To this end, the equation of motion of the structure is formulated in the state space then a MATLAB program developed to determine the structural response under seismic base excitation before and after developing stiffened storey. To find the optimum location and corresponding lateral stiffness value, the Charged System Search (Kaveh and Talatahari, 2010) is used as a population-based meta-heuristic optimization algorithm. In this study the maximum first storey displacement, x_1, and the transfer function, TF_1, of the structure with and without stiffened storey is calculated in the program then the objective function defined as below (Bekdas and Nigdeli, 2011).

$$Objective\ funtion = \frac{\left(Max\ |x_1|\right)_{Stiffened}}{\left(Max\ |x_1|\right)_{Unstiffened}} + \frac{\left(Max\ (TF_1)\right)_{Stiffened}}{\left(Max\ (TF_1)\right)_{Unstiffened}} \quad (1)$$

The transfer function, which is used for analysis, is the ratio of the Laplace transformations of the first storey acceleration and ground acceleration. It should be noted that the transfer function is independent of the type of output component and therefore considered as an inherent property of the structure. After formulating the problem, some numerical example are conducted to ensure the effectiveness of the proposed model. The result show that in the all cases the structural response can be reduced by the selection of optimum location and property of the stiffened storey.

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