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MITIGATION OF STRUCTURAL RESPONSES BY INTRODUCING A MODIFIED SELF-REGULATING MODEL FOR TUNED LIQUID DAMPERS (TLDS)

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The occurrence of severe seismic events and the vulnerability of most of the buildings have caused dire casualties, huge financial losses and catastrophes. In that sense, many control systems over the past decades have been introduced in order to reduce the response of the structures. Among different control systems, the passive types have been quite popular due to their simple structure, no need to energy sources, and no introducing structural insatiability. The Tuned Liquid Damper (TLD) has been one of the successful kind of passive control systems. However, like any other passive system, it is unable to adapt to different loading scenarios, and only performs effectively in the frequency domain which had been tuned initially.

TLD is a kind of mechanical damper, which consists of a reservoir containing a fluid (such as water) and operates based on the use of hydrodynamic properties of fluid. This system employs several mechanisms such as layer boundary friction, sloshing and waves breakdown, in order to mitigate the earthquake energy transferred into the structure, Figure 1. When the primary vibration frequency of the structure is near or equal to the natural vibration frequency of the tank's liquid, which is the resonance state, the different phase between the excitation and base shear in the TLD causes energy dissipation. At this situation, the damper performs on its maximum efficiency. There are many researches which have performed theoretically and/or experimentally about TLDs, all the presented references are as examples. TLDs may also be considered and designed as a water storage tank in a building. However, due to the use of water, the change of height of the reservoir liquid is inevitable which would result in the change of the specification of the damper and its regulatory frequency.

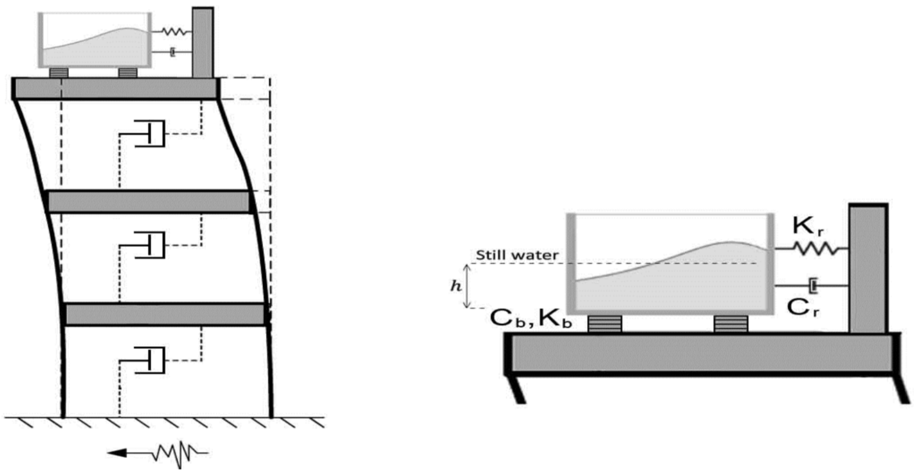

Figure 1. Tuned Liquid Damper (TLD).

The main purpose of this paper is to introduce a Tuned Liquid Damper system, which can perform in its maximum efficiency regardless of the height of the water in the reservoir. In fact, it is a modified self-regulating model for Tuned Liquid Dampers. The proposed system which is equipped with a combination of isolators, control springs and viscous dampers, can be programmed for different heights of water to achieve the best efficiency in reducing structural responses. The proposed control system is modeled and analyzed for nonlinear time histories by OPENSEES software for steel moment frame structures with different heights categories (9, 15 and 20 stories).

In the performed analysis, the maximum structural responses such as: stories displacements, accelerations, speeds, and the stories drifts are investigated under the applying seven series of earthquake records. The required specifications are conformed to the 4th edition of the 2800 national Iranian loading code. The buildings are special steel moment frames located on the soil type III according to aforementioned code. To achieve the most reduction in the responses, the characteristics for the different components of the proposed control system have been changed repeatedly and the optimal state for each water height is then specified. The comparison of the building responses in two cases, one with no-controlled systems and the other equipped with the proposed control system, reveals the excellent performance of introduced control system. The results show a reduction of responses between 18 to 40 percent compared to the buildings in the absence of the suggested control system.

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