CED : « Engineering Sciences and Techniques »

THESIS DEFENSE

«MOHAMED AMINE ABID»

CANDIDATE FOR DOCTOR SCIENCES AND TECHNIQUES

« Study of Dynamic Behavior and Seismic Reinforcement of Civil Engineering Structures »

Date :	**Saturday 24 june 2023**
Time :	**10 am**
Location :	**Seminar Room, Mechanical Engineering Department, FST - Tangier**

Committe Members		
Pr. Rachid DKIOUAK	FST - Tangier	Chair
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ABSTRACT

Devastating earthquakes in recent years have affected Syria and Turkey, causing significant loss of life and widespread damage to buildings and infrastructure. These events have underscored the importance of resilient building design in regions prone to seismic activity. In civil engineering to improve the resistance capacity of structures against earthquakes passive energy dissipation devices, bracing systems, and moment resisting frame are well-known techniques used. Passive energy dissipation devices work by absorbing and dissipating seismic energy, thereby reducing the forces transmitted to the structure and minimizing damage. Dampers are a type of passive energy dissipation device that helps reduce vibrations and control the motion of structures during an earthquake. Bracing systems provide additional support and rigidity to the structure, preventing lateral movements and reducing the risk of collapse. A moment resisting frame is a type of structural system used in building construction to provide lateral resistance against forces such as earthquakes and wind. This is achieved through moment connections between the beams and columns of the frame, which are designed to transfer lateral loads and resist bending moments. These connections reduce lateral deflection, making MRFs effective in areas with high seismic or wind loads. By implementing these techniques, engineers can increase the overall resilience of a structure and ensure that it can withstand seismic activity and protect its occupants.

During a strong earthquake, a building's structure is at risk of significant damage from ground movements and forces. Without passive energy dissipation devices, bracing systems, or moment resisting frame, the building's inherent damping provides its only resistance to seismic loads. Inherent damping refers to a building or structure's ability to absorb and dissipate energy during seismic events or other dynamic loading conditions, determined by the material properties and geometrical characteristics of components such as the foundation, columns, and beams. Hence, in the case of a structure building without using these above-mentioned techniques, the seismic load absorbed by the structural components, especially the columns, may exceed their load-carrying capacity, resulting in column failure. When a column fails, the load it was supporting is transferred to the surrounding columns. Therefore, if the structure is not designed to support a column loss, this may result in the spread of local failure until the entire structure collapses. This phenomenon is called progressive collapse.

This thesis will be divided into four parts. In the first part, the results will be determined analytically using mathematical formulations. In the second part, the dynamic response of the structure will be evaluated using both analytical methods and the finite element software SAP2000. In the third and fourth parts, the structural system's response subjected to lateral forces and column loss, respectively, will be analyzed using the software SAP2000. In this thesis, several codes and guidelines will be followed and presented later. The first part will evaluate the ability of passive energy dissipation devices to reduce the dynamic behavior of a building subjected to seismic loads. The required damping coefficients by the linear and nonlinear viscous dampers to provide the same damping ratio will also be determined. The effect of lateral stiffness will be concluded using the beam to column stiffness ratio, and the energy dissipated by the dampers will be calculated to validate the provided formulas. In the second part, the linear and nonlinear viscous dampers will be retrofitted in a steel building, and their effect on reducing its vibration due to different earthquakes will be studied. The energy dissipated by the dissipation system and the structure inherent damping will be presented and investigated. The behavior of the linear and nonlinear dampers will be discussed, and the effect of the viscous dampers behavior on varying the inter-story drift, displacement of stories will be evaluated. In this part, the required damping coefficients for the linear and nonlinear viscous dampers to provide the same damping ratio will be determined using a different formulation than that used in part one. The presented study in the third part aims to investigate the dynamic response of a structural system designed as a moment resisting frame when subjected to both harmonic and seismic excitations. The study also examines the effectiveness of various viscous dampers in reducing the structure's dynamic behavior. Additionally, the study investigates the impact of incorporating several bracing systems, using pinned connections to connect the beams and columns, on enhancing the structure's dynamic response. These investigations and evaluations are conducted using computed results from nonlinear dynamic analyses. Furthermore, a nonlinear static analysis is performed to compare the ability of the moment resisting frame and the bracing system to improve the structure's resistance capacity. Finally, based on the results of the latter analysis, the optimal bracing system is determined. In the final part, a structure is assumed to be missing one of its critical columns, and its resistance capacity to progressive collapse will be determined using linear static and nonlinear dynamic analysis. Several structures with different beam cross-sections, steel grades, span lengths, and numbers of stories will be examined. The aim of this part is to evaluate the contribution of these latter parameters in varying the resistance capacity of the structure against the spread of the column failure (progressive collapse).

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