NEW CONTRIBUTIONS OF THE THESIS

1. **Thesis name: Research on outrigger braced concrete tall buildings subjected to earthquake in Vietnam**.
2. **Specialization:** Civil Engineering **Student ID:** 62.58.02.08
3. **PhD Candidate:** Nguyen Hong Hai
4. **Email:** hai.nguyen@ibst.vn
5. **Supervisors:** Asso.Prof. Dr. Nguyen Xuan Chinh
   Dr. Ngo Tuan
6. **Education Organization:** Institute for Building Science and Technology

The thesis had achieved some main results as follows:

1) The performance based seismic design (PBSD) is being considered a new trend of seismic-resistant design. In comparison with traditional force-based seismic design methods, the method has advatages in qualitatively evaluation of performance of structures associated with relevant seismic hazard levels and of time-history structural responses during the earthquake motions. The method is especially pertinent for buildings with complex structural system. Proper design of structures, avoiding unexpected damages and unstable schemes, can be implemented by mean of controlling appropriate plastic hinge formation through nonlinear analyses. Structural nonlinear analyses also help to evaluate the behavior factor used in the preliminary analyses in accordance with practice design codes.
2) To establish a PBSD procedure for concrete high-rise buildings, emphasizing on application of the method for design practice in Vietnam.
3) Through literature review and parametric study results, it is shown that acceleration and displacement response spectra in the TCVN 9386:2012 with the corner period of 2s are not appropriate for matching ground motions used for time-history analyses and determining target displacement in pushover analyses for tall buildings. Recommendation of using ASCE 7 spectra as an alternative is given.
4) When creating artificial ground motions for time-history analyses, hard-to-soft soil ground motion amplification effects should be considered. The actual soil conditions at construction site shall be used.
5) To develop a computer program determining target displacement and calculating behavior factor based on capacity curves obtained from nonlinear analyses.
6) Outrigger stiffness should be properly adjusted not only to control lateral displacement but also to limit sudden changes of internal forces of structural elements around outrigger levels, optimizing structural design.

7) To carry out experimental studies of performances of column-outrigger connections. From testing results of 02 specimens, some remarks are given as follows:

   a. Elasto-plastic hysteresis rules can be used for modeling of column-outrigger connections when carrying out nonlinear analyses;

   b. Design the connections with over strength of shear capacity and sufficient desired ductility. This can be assured though nonlinear analyses, controlling structure strength at a proper level to maintain shear forces while satisfying local ductility and global lateral displacement requirements.

   c. Columns lower and above outriggers should not be designed at high level axial forces in order to avoid premature strength degradation when subjected to large earthquakes.

   d. When designing of the connections, column stirrup spacings should be considered in order to secure stability of longitudinal bars. The issue is particular important to the embedded areas of columns into the outriggers.

ACADEMIC SUPERVISOR **PHD CANDIDATE**

A.Prof. Dr. Nguyen Xuan Chinh **Dr. Ngo Tuan** **Nguyen Hong Hai**