



*Project Title:* Innovative Design Technique for Steel-concrete Composite Structures in Hong Kong  
*Principal Investigator:* Ir Prof. Siu-Lai CHAN  
*Project ID:* CICR/03/12  
*Research Institution:* The Hong Kong Polytechnic University  
*Subject Area:* Construction Productivity

## Objective

Proposed a unified second-order design approach and a practical advanced analysis method for the hybrid steel and concrete composite structures for improvement in productivity and efficiency.

## Background

To overcome the problem of labour shortage, more efficient structural form like composite structures should be used. Then research and development of the behaviour of composite structures and its design method should be carried out. The method investigated is generally called the second-order plastic analysis method of design. This design method was not used in the past because of the complexity in modelling and difficulty in getting the numerical solutions. To avoid this tedious modelling, engineers normally adopt the less economical and safe method of design called the linear elastic design method. The limitation of this old method is that it ignores the large deflection and material yielding effects, leading to over-design redundant members and under-design critical members.

## Methodology

- ♦ Develop an elasto-plastic design method for composite structures;
- ♦ Formulate design technique to allow for pinned, rigid and semi-rigid connections with high-strength bolts;
- ♦ Derive a rational model for plastic-hinge analysis of composite, steel and reinforced concrete structures and
- ♦ Verify the accuracy of the design method against experimental test and code formulae;

## Results and Findings

- ♦ Proposed a new beam-column element with the allowance for initial member curvature and capability for simulating large deflections and inelastic behavior;
- ♦ Developed an analytical model for advanced analysis by one element per member;
- ♦ Developed an accurate and robust cross section analysis technique for arbitrary sections in a hybrid steel and concrete framed structure;
- ♦ Extended the refined plastic hinge model for various material types of structural members in a hybrid steel and concrete frame;
- ♦ Introduced a unified and practical second-order design approach, which was recommended in Eurocode 3 and 4;
- ♦ Studied the proper inputs of the material constitutive models;
- ♦ Proposed a practical and efficient advanced analysis approach for the hybrid steel and concrete frames.



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## **Recommendations**

- ♦ Putting the work to design codes and publications of design guidelines.
- ♦ Developing a cloud-based technology for building design.
- ♦ Promoting the use of advanced composite construction.
- ♦ Developing simplified and practical models based on beam-column, shell and discrete spring finite elements to simulate the overall structure response.
- ♦ Developing design concept to study structural robustness against progressive collapse.

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