IOSUD - Universitatea Politehnica Timişoara
Şcoala Doctorală de Studii Inginereşti

SEISMIC PERFORMANCE OF COMPOSITE STEEL-CONCRETE SHEAR WALLS WITH CENTRAL OPENINGS

PhD Thesis - Summary

for obtaining the scientific title of Doctor of Philosophy at the
Politehnica University of Timisoara
in the field of Civil Engineering and Building Services Engineering

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1. Abstract

The thesis presents a series of experimental results and theoretical aspects which describe the seismic performance of composite steel-concrete shear walls with steel profiles partially embedded at the edges and central openings, subjected to vertical and horizontal cyclic loads simulating the effect of an earthquake. This structural system is often met in case of tall buildings, being used to and to limit the lateral displacements of the building and to dissipate the seismic energy in case of an earthquake event. Based on the author's knowledge, this kind of researches are not thoroughly approached in the literature and need to be extended, to present the advantages and the deficiencies of this structural system. The composite steel-concrete shear walls are generally composed of a reinforced concrete web panel in which steel profiles with different cross-sections are embed at the edges, the connection between both materials being assured, naturally by adherence or mechanically using shear connectors. The composite steel-concrete shear walls were conceived mainly to solve some technological issues or to increase the structural performance of the conventional reinforced concrete walls. The main objective of the thesis was to identify new structural solutions in order to obtain a higher seismic performance than that developed by the conventional reinforced concrete walls. Taking into consideration the technological issues from the construction phase of the reinforced concrete walls, different solutions which assure the shear connection between concrete and steel profiles were included in the experimental program. Moreover, the use of steel fibers reinforced concrete was investigated. The theoretical and experimental study of the current research was detailed based on the next chapters as follows:

2. Thesis outline

Chapter I: Introduction

In this chapter the motivation of the study, the main objectives and the applicability of the research are shortly described. The research framework of the thesis is mainly addressed to civil engineers, designers, workers or researchers, being applicable especially on tall buildings but also to low- and mid-rise ones. The motivation of the thesis resides in the identification of new structural solutions for composite steel-concrete shear walls, to obtain higher seismic performances than those of the conventional reinforced concrete walls and the main objective was to study the seismic behaviour of the composite steel-concrete shear walls with partially steel profiles embedded on the edges and central openings.

Chapter II: State of knowledge

In chapter two, based on the experimental and theoretical studies found in the literature, some aspects which describe the state-of-the art issues on this topic were addressed: the seismic behaviour of reinforced concrete coupled shear walls, the seismic performance of the reinforced concrete coupling beams highly influenced by the aspect ratio or by the reinforcement type, as well as aspects which describe the seismic behaviour of the composite steel-concrete solid shear walls or with central openings [1-17]. The chapter concludes with a selection of impressive tall buildings which embed and use the structural system made of composite steel-concrete shear walls, to withstand against horizontal forces from wind action or earthquakes, as a further proof of the theme's applicability.

Chapter III: Design and detailing of composite steel-concrete shear walls

In chapter three, some provisions related to the design and detailing of composite steel-concrete shear walls, based on the existing national codes or European standards, are summarized. Also, some details related to the cross-sectional arrangement, the connection between structural steel and concrete are specified, as well as seismic provisions which assure a ductile failure mode of the walls. Moreover, in the end of the chapter, some details and seismic provisions related to the seismic design of coupling beams are presented [18-21].

Chapter IV: Experimental program

In chapter four, the main characteristics of the research experimental program are presented. Five structural walls constructed at a reduced scale 1:3 were subjected to cyclic lateral loads to full failure, in order to investigate and to evaluate their seismic behavior, the obtained results being presented for comparative studies in the end of the chapter [22-26]. Also, in this section of the thesis, the construction details of the specimens are highlighted, the mechanical properties of the materials used to construct the walls, the stand setup or the testing procedure adopted in the experimental tests.

Chapter V: Experimental results

In chapter five of the thesis, the seismic performance in terms of bearing capacity, lateral stiffness or ductility were analysed between the experimental specimens to express the advantages or the deficiencies of these structural systems. The failure modes and the crack patterns developed by the specimens during the experimental tests were recorded and also presented. It was shown that composite steel-concrete shear walls coupled by conventional reinforced coupling beams developed a low level of ductility and a low capacity to dissipate the hysteretic energy during the loading cycles in comparison with the performance recorded by the solid composite wall considered as reference.

Chapter VI: Numerical analysis and modelling

A series of numerical modelling and analyses were performed to numerically simulate the seismic behaviour of the experimental specimens, the results being presented over the sixth chapter. Similarly, in this chapter were presented the material laws which describe the mechanical performance of the materials, the overall geometry of the walls and also some rules adopted to define the contacts between the surfaces or the boundary conditions. The numerical results reflect with a high accuracy the seismic response of the specimens recorded during the experimental tests.

Chapter VII: Conclusions and personal contributions

In chapter seven, the main conclusions of the research and the personal contributions of the author were detailed. The results of the research were disseminated through more than fifteen scientific papers and by participating in numerous scientific events or conferences.

Bibliography

The bibliography includes doctoral thesis, scientific articles from journals or international or national conferences, investigation reports as well as technical information's found in standards or European codes, or software's used in the research.

Annex A

Includes a list of figures and tables which describe the position of the equipment's and instrumentation mounted on each specimen during the experimental tests.

3. Bibliography

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