Portofoliu de 10 lucrări ştiinţifice relevante
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List of 10 relevant scientific publications

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Dual high-strength steel eccentrically braced frames with removable links

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SUMMARY

Structural damage in buildings designed according to the dissipative design philosophy can be significant, even under moderate earthquakes. Repair of damaged members is an expensive operation and may affect building use, which in turn increases the overall economic loss. If damage can be isolated to certain dissipative members realized to be removable following an earthquake, the repair costs and time of interruption of building use can be reduced. Dual structural configurations, composed of a rigid subsystem with removable ductile elements and a flexible subsystem, are shown to be appropriate for the application of removable dissipative element concept. Eccentrically braced frames with removable links connected to the beams using flush end-plate bolted connections are investigated as a practical way of implementing this design concept. High-strength steel is used for members outside links in order to enhance global seismic performance of the structure by constraining plastic deformations to removable links and reducing permanent drifts of the structure. Copyright © 2008 John Wiley & Sons, Ltd.

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KEY WORDS: dual configuration; high-strength steel; eccentrically braced frames; removable bolted links; seismic performance

1. INTRODUCTION

The present paper investigates seismic performance of eccentrically braced frames with removable links with flush end-plate bolted connections. The objective is to avoid inelastic deformations in structural elements outside links and to allow easy repair of structural damage experienced during a seismic event.

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DUAL ECCENTRICALLY BRACED FRAMES WITH REMOVABLE LINKS: EXPERIMENTAL VALIDATION OF TECHNICAL SOLUTION THROUGH LARGE-SCALE PSEUDO-DYNAMIC TESTING

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Abstract: Conventional seismic design philosophy is based on dissipative structural response, which implicitly accepts damage of the structure under the design earthquake and leads to significant economic losses. Repair of the structure is often impeded by the permanent (residual) drifts of the structure. The repair costs and downtime of a structure hit by an earthquake can be significantly reduced by adopting removable dissipative members and providing the structure with re-centring capability. These two concepts were implemented in a dual structure, obtained by combining steel eccentrically braced frames (with removable bolted links) and moment resisting frames. The bolted links provide the energy dissipation capacity and are easily replaceable, while the more flexible moment resisting frames provide the necessary re-centring capability. The paper presents the results of a large scale experimental program on a dual eccentrically braced frame with replaceable links performed at the European Laboratory for Structural Assessment (ELSA) at the Joint Research Centre in Ispra within the framework of Transnational Access of the SERIES Project. The objectives were to validate the re-centring capability of dual structures with removable dissipative members, assess overall seismic performance of dual eccentrically braced frames and obtain information on the interaction between the steel frame and the reinforced concrete slab in the link region. Pre-test numerical simulations were performed in order to assess the response of the structure under different levels of the seismic input, as well as to establish the optimal sequence of link removal and replacement. The general set-up of the experimental mock-up, instrumentation, the test sequence, and preliminary test results are presented.

Keywords: re-centring, bolted links, repair.

1. Introduction

Structural systems that aim at reducing structural damage by isolating plastic deformations in removable or "repairable" elements, and have the ability to return to the initial undeformed shape after an earthquake have received much attention recently. One of the solutions applicable to steel moment-resisting frames relies on post-tensioned beam to column joints [1] and column bases [2]. Other solutions having the same performance objectives use beam to column joints assembled with shape memory alloy connecting devices [3]. Vargas and Bruneau [4] investigated a design approach aiming to concentrate damage on removable and

FULL – SCALE TESTS ON COLD-FORMED STEEL PITCHED-ROOF PORTAL FRAMES WITH BOLTED JOINTS

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ABSTRACT: The paper summarises the results of an experimental program carried out in order to evaluate the performance of pitched roof cold-formed steel portal frames of back-to-back channel sections and bolted joints. Three different configurations of ridge and eaves joints were tested. The behaviour and failure mechanisms of joints were observed in order to evaluate their stiffness, strength and ductility. Joints between cold-formed members with bolts in the web only result in a reduction of joint moment capacity and premature web buckling. The component method was applied in order to characterise the joint stiffness and moment capacity for the purpose of frame analysis and design. The influence of joints characteristics on the global frame response under lateral (seismic) loads was analysed by considering three connection models. Full-scale tests were performed on cold-formed pitched-roof portal frames. The paper presents experimental observations and comparison to numerical predictions of frame response.
Keywords: Cold formed construction, pitched roof portal frames, joint behaviour, full-scale tests

1. INTRODUCTION

Previous studies by Lim and Nethercot [1] and Chung and Lau [2] showed that bolted joints in cold formed steel portal frames have a semi-rigid behaviour. Also, these types of joints are partially resistant (Lim and Nethercot [3]). When bolts are installed only on the web of cold-formed section, the local buckling is made more critical by stress concentrations, shear lag and bearing deformations around bolt holes (Dundu and Kemp [4]), reducing the moment resistance well below the moment resistance of the effective cross-section. In case of usual cold-formed steel sections, both tests and numerical simulations show that elastic-plastic elongation of bolt-holes is by far the most important component controlling the stiffness and capacity of such type of connections (Lim and Nethercot [1], Yu et al. [5]). The contribution of other components, such as flanges in tension and compression due to bending action, and the web in shear due to transverse action is significantly lower.

The global behaviour of cold-formed steel portal frames of bolted joints was studied experimentally by Lim [6], Dundu and Kemp [4], and Kwon et al. [7]. All these studies provided evidence of the crucial importance of joint performance on the global response of frames.

In present paper, the influence of joint characteristics on the global behaviour of cold-formed pitched-roof portal frames is investigated. An experimental program on ridge and eaves joints was carried out. Detailed results on joint behaviour are reported elsewhere (Dubina et al. [8]). Based on experimental results, a calculation procedure based on the component method (EN1993-1-8 [9]) was adapted to cold-formed joints. Joint stiffness and moment capacity obtained using the component method is used to develop a joint model for global structural analysis. Two full-scale tests on cold-formed pitched-roof portal frames with bolted joints were performed, with the primary objective to assess their performance under horizontal (seismic) loading. The results of the experimental investigation are presented and experimental response is compared to analytical predictions of frame response.

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NUMERICAL SIMULATION OF THE CYCLIC LOADING FOR WELDED BEAM-TO-CFT COLUMN JOINTS OF DUAL-STEEL FRAMES

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Abstract: Dual-steel structural systems, in which mild carbon steel is used in dissipative members while high strength steel is used in non-dissipative 'elastic' members, can be very reliable and cost efficient. Because present seismic design codes do not cover this specific configuration, a research project started with the aim to investigate and evaluate the seismic performance of dual-steel building frames. The frames are considered to be moment resisting frames, dual concentrically braced frames and dual eccentrically braced frames. The paper makes a short description of the research project and the experimental program to be performed at the 'Politehnica' University of Timisoara.

A number of numerical simulations have been performed for the beam-to-column joints that will be tested with the aim to assess their behavior under monotonic as well as cyclic loading. The material model used in the numerical simulations was calibrated based on the results from tensile tests. The assumptions considered in the modeling of the specimens, the loading procedure, as well as the results from the numerical analysis are finally presented.

Keywords: High strength steel, Welded beam-to-column joints, Concrete filled tubes

1. Introduction

The design philosophy of a structure to seismic action allows for plastic deformations in dissipative members, the global stability of the structure being provided by the non-dissipative members. For this reason, in the current research project, the beams are made of mild carbon steel and the columns of high strength steel (*Fig. 1*). The investigated frames are considered to be Moment Resisting Frames (MRF), Dual Concentrically Braced Frames (D-CBF) and Dual Eccentrically Braced Fames (D-EBF).

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BEAM-TO-COLUMN JOINTS FOR SEISMIC RESISTANT DUAL-STEEL STRUCTURES

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Abstract: Dual-steel structural systems represent an innovation in seismic design in Europe. This type of structures, in which mild carbon steel (MCS) is used in dissipative members while high strength steel (HSS) is used in non-dissipative 'elastic' members, can be reliable and cost efficient. Because actual seismic design rules do not cover this specific configuration, a research project started with the aim to investigate and evaluate the seismic performance of dual-steel building frames. The paper makes a short description of the research project and presents the experimental program to be performed. For the beam-to-column joints that will be tested, a number of numerical simulations have been realized with the aim to anticipate their behavior and to find answers to problems for which decisions were taken in the design process. Finally, the results from the numerical analysis are presented.

Keywords: High strength steel, Welded beam-to-column joints, Concrete filled tubes, Shot fired nails

1. Introduction

The ongoing research project HSS-SERF (High Strength Steel in Seismic Resistant Building Frames) has the aim to investigate and evaluate the behavior of structures realized from two types of steel grade. This kind of structure is termed dual-steel structure, and represents an innovation in seismic design in Europe. Additionally, it can be very reliable and cost efficient [1], [2]. However, the actual seismic design rules [3], [4] do not cover this specific configuration. Furthermore, adoption of current code procedure to dual-steel structures involving mixed use of mild carbon steel and high-

PROTECTION OF HISTORICAL BUILDINGS

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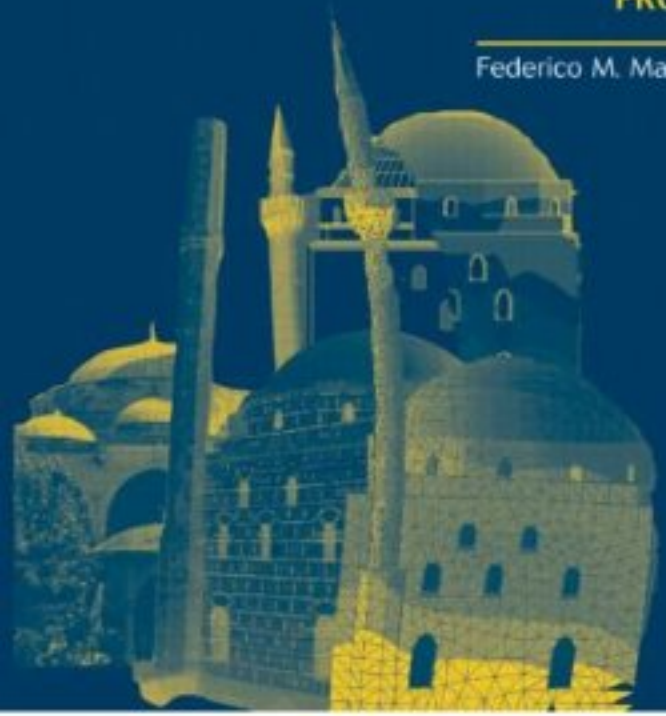

CRC Press

VOLUME 2

Performance Based Evaluation of a RC Frame strengthened with BRB Steel Braces

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ABSTRACT: Reinforced concrete (RC) building frames located in severe, even moderate seismic zones, designed for gravity loads only in the past, need for seismic upgrade in order to comply with modern seismic design requirements. Among other dissipative passive systems, the Buckling Restrained Braces (BRB) systems can be used on this purpose. The main effect of the dissipative bracing system is the improvement of overall strength, stiffness and ductility of the building framing. In present paper, the effectiveness of both strengthening and increasing ductility provided by the BRB intervention in non-seismic reinforce concrete frame is examined. The BRB members have been designed to respond to the strengthening demand resulted from non-linear analysis and tested in order to observe their functionality.

1 INTRODUCTION

Romania is a country of moderate to high seismic risk. The first compulsory seismic design code was issued in 1963. The RC structures built before 1963, were designed to resist only gravity loads, mainly. Later, new codes were drafted (e.g. 1978, 1992, 2006) the last one being aligned with Eurocode 8. Practically, almost all the buildings located in severe seismic zones and gravity load designed must be evaluated and strengthened.

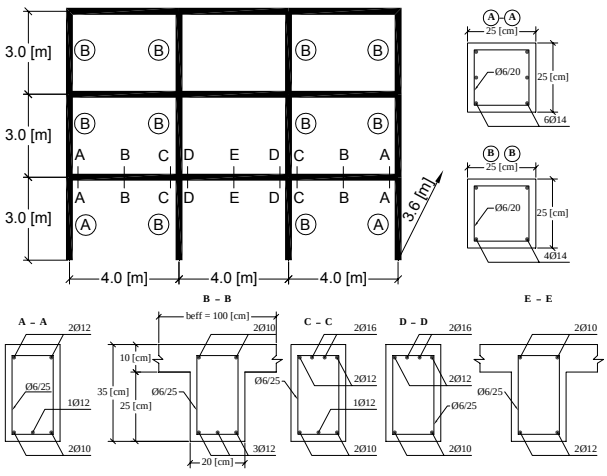
In present paper a “typical” RC frame designed and build according to the technical regulation of 1950-s is first evaluated and, after, strengthened with an inverted V BRB system. The BRB system is applied in the middle spans of the frame. Additionally, FRP local confinement of the columns was considered (see Fig. 1). The confinement was applied only on the columns from the first two stories. The analysis was performed on RC frame strengthened by means of BRB with/without fiber reinforced polymers (FRP) confinement. BRB are designed to resist and provide the necessary ductility to the frame. In order to check their effectiveness and the correlation with numerical model assumptions the BRB members have been tested.

2 EFFECTIVENESS OF BRB STRENGTHENING OF A MOMENT RESISTING FRAME OF POOR REINFORCED CONCRETE

Since the authors have already reported the numerical results of their study (see Dubina et al. 2007), the present paper is mainly focused on the experimental results and the comparison with corresponding theoretical values.

2.1 *Frame description*

The frame geometry and cross sections are presented in Figure 1.



Masonry walls strengthening with innovative metal based techniques

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ABSTRACT: Two innovative strengthening solutions for masonry walls are presented. First one consists in sheeting some steel or aluminium plates either on both sides or on one side of the masonry wall. Metallic plates are fixed either with prestressed steel ties, or using chemical anchors. The second one is derived from the FRP technique, but applies a steel wire mesh bonded with epoxy resin to the masonry wall. Both these techniques are described together with the experimental program carried out at the "Politehnica" University of Timisoara on the aim to validate them.

1 INTRODUCTION

1.1 *Importance of masonry buildings*

Masonry buildings are widely spread in Europe. Most of these structures represent historical constructions with symbol value for many towns or countries. Their functionality is diverse, including residential houses, hospitals, schools and other essential facilities. Therefore, these types of structures are important from many points of view: life safety, economical aspects and cultural heritage preservation.

Erected in a period when design methods where poor or missing, and the knowledge regarding seismic action was almost inexistent, these buildings need a structural upgrade in order to respect safety criteria of modern codes.

1.2 *Masonry behaviour*

Poor behaviour of masonry structures under seismic action is due to the lack of resistance, tensile stress mainly, small deformation capacity and low ductility. Moreover, under seismic action the masonry, because it is stiff and heavy, attracts significant inertial forces.

Common damage patterns for masonry buildings recorded during earthquakes can be classified in the following four categories:

- Out-of-plane damage or collapse of walls;
- In-plane shear or flexural cracking of walls;
- Loss of anchorage of walls to floor or roof diaphragms;
- Damage or collapse of corners.

Out-of-plane failure modes, e.g. falling down, can be a result of: load capacity exceeded due to inertial seismic forces, excessive deflection imposed on walls from diaphragm action, lack of anchorage, poor possibility of transferring deflection and inertial forces to horizontal elements.

In-plane damage can be a result of: diagonal cracking through masonry units due to excessive principal stress (tensile stress), shear sliding along bed joints, excessive toe compressive stress causing crushing (sliding shear), or tensile cracking normal to bed joints resulting in rocking (bending).

The interaction of in-plane and out-of-plane forces has as consequence failure of corners.

This paper will focus on strengthening techniques aiming to improve the in-plane behaviour of masonry panel. However, they obviously enhance the out-of-plane resistance, too.

1.3 *Objective of modern consolidation philosophy*

The objective of traditional consolidation techniques was mainly the local repair of damaged elements without a general strategy related to the global behaviour of the structure.

At present, not only the impact of local strengthening on the global response of the structure has to be considered, but also the reversibility of the used techniques and compatibility between materials, the added and existing ones (e.g. the "mixed" action) have to be analysed and evaluated.

The reversibility is very important because it offers the possibility to remove a solution when more advanced technology will be available.

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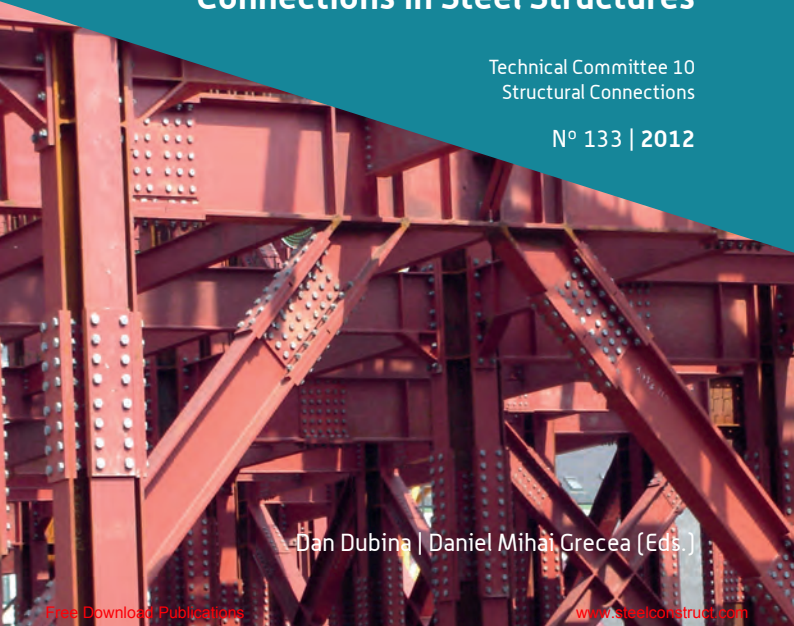

Dan Dubina | Daniel Mihai Grecea (Eds.)

EXPERIMENTAL VALIDATION OF A BRACE WITH TRUE PIN CONNECTIONS

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ABSTRACT

Circular hollow section braces with "true pin" connections were adopted in the design of a 29 storey building located in Bucharest, Romania. The brace uses connections with gusset plates and pin. One of the brace connections has an eccentric pin, allowing for variation of the pin-to-pin length, which facilitates erection on one hand, and allows compensation for axial forces in braces due to gravity loads on the other hand. High strength steel was used for gussets and pin, in order to keep connection dimensions to a minimum. Finite element analyses and cyclic experimental tests were performed in order to validate the seismic performance of the brace and its connection. Four tests were performed on a scaled model of the brace, for two different pin-to-pin lengths.

1. INTRODUCTION

A multi-storey building with two underground and 29 levels above ground is under design in Bucharest, Romania by SC Popp & Asociatii SRL. In-plan dimensions of a typical floor are 52.0x25.6 m, while the total height amounts to 117.6 m. The structure uses steel framing for resisting gravity forces. In the transversal direction the main lateral force resisting system is composed of two reinforced concrete cores, while in the longitudinal one the cores are supplemented by steel braces located in the facade of the building. The braces are placed in X configuration developed over two storeys. This reduces the number of brace connections and helps in complying with code limitations on slenderness. Braces are realised from hot-finished Circular Hollow Sections (CHS) and have connections with pins. The structure was designed according to EN 1993-1-1 (2005) and P100-1 (2006) – the Romanian seismic design code, which is very similar to EN 1998-1 (2004). The connections were designed according to EN 1993-1-8 (2005).

There two brace configurations: developed over two storeys, of 9300 mm pin to pin length (see Figure 1a), and developed over one storey, with an additional connection at the beam from the intermediate storey, of 4200 mm pin to pin length (see Figure 1b). The initial design used the following cross-sections: D244.5x25, D244.5x20, D219.1x20, D219.1x16 and D219.1x10, all in S355 steel. One of the pins of each of the brace features an eccentricity of 5 mm, allowing a +/- 5 mm adjustment of the pin to pin length of the brace. This allows for more relaxed erection tolerances on one hand, and reduces gravity-induced axial forces in the brace on the other hand, as the eccentric pin is mounted after casting of reinforced concrete floors.

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EXPERIMENTAL VALIDATION OF A STRAIN HARDENING FRICTION DAMPER

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The general aim of the research program is to establish the seismic performance of multistorey steel concentrically braced structures equipped with strain hardening friction damper in the braces. This paper presents the experimental program conducted at the CEMSIG research center of the Politehnica University of Timisoara to validate the behaviour of the damper and to determine the performance of a brace with damper assembly. The experimental results are used to calibrate a numerical model for the damper and damper with brace assembly in order to determine the performance of this structural system. A companion paper (Norin FILIP-VACARESCU et all.) presents the numerical model for the combined behaviour of a brace equipped with such a friction damper calibrated on experimental data and used in numerical simulations to determine the performance of concentrically braced frames equipped with strain hardening friction dampers in the braces.

Key words: friction damper, strain-hardening, seismic performance.

1. INTRODUCTION

Recent earthquakes around the globe proved that the current degree of seismic protection is unsatisfactory and buildings suffer extensive damage or even collapse when subjected to severe or even moderate earthquake activity. As a consequence the building design codes increase seismic demands and aim to improve structural response capacity through accuracy of design and enhanced technical solutions. In current practice there are three efficient strategies to reduce seismic risk (Fig.1): (1)reduce seismic forces, (2) appropriate the structural response to seismic demand and (3) enhance structural damping.

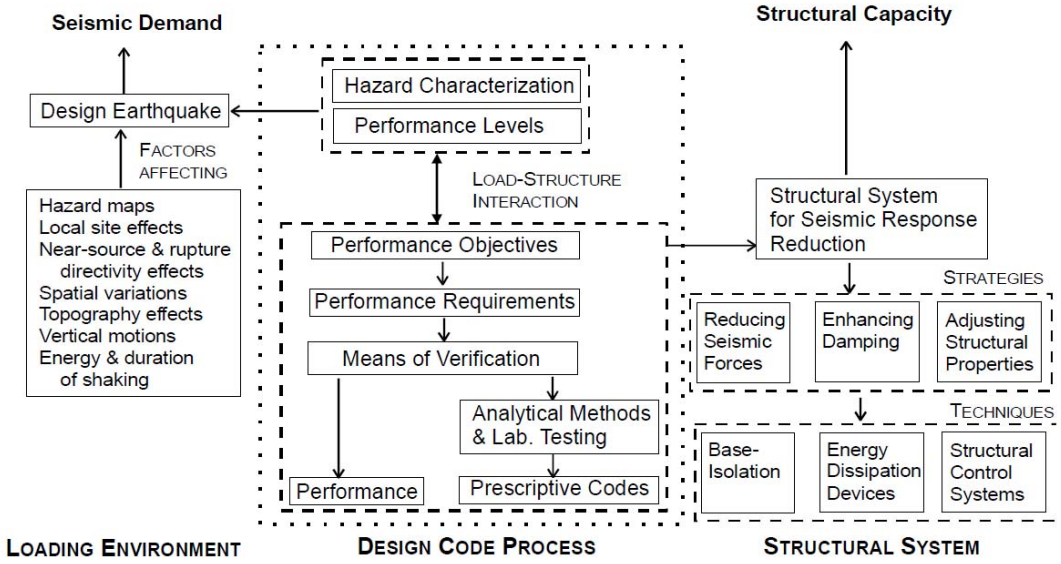

Fig.1 – Seismic demand vs. structural capacity: protection strategies [1].

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Numerical Simulations of Bolted Beam to Column Connections with Haunches in Steel Moment Frames

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Abstract

The paper presents the numerical pretesting of bolted extended end plate connections with haunches from European experimental project European pre-QUALified steel JOINTS. Design codes require that seismic performance of beam-to-column connections in steel moment resisting frames be demonstrated experimentally. A solution to this problem is the prequalification of connections typical in the design practice. The use of prequalified steel joints is a common practice in United States and Japan, but absent at the European level. The project will carry out extensive numerical and experimental testes. The project EQUALJOINTS aims to propose relevant provisions for the next version of EN 1998-1.
Research will be responsible for standardizing the design and implementation procedure of steel joints according to different geometrical and mechanical parameters. The project will conduct a comprehensive experimental program based on theoretical analysis and numerical aimed at standardizing connections to be easily used by designers in practical applications. The models will be used to perform parametric studies on the selected nodes to extend the experimental results. The results of experimental and numerical tests will come in a database of pre-qualified connections
To establish the experimental programs were analysed several parameters of joints typology. Existing experimental results were used to calibrate the numerical model for materials and for preloaded bolts. Also for choice of specimen for the experimental tests was considered several parameters in numerical analysis. Influence of members size was considered for three sections of IPE European profiles. Influence of haunch geometry was analysed for two values of 30° and 45° angle and clear span – to – depth ratio.

Keywords: preloaded bolts, haunch, plastic hinge, overstrength factor, plastic strain.

1. Introduction

The current paper presents a set of numerical simulations conducted at the Politehnica University of Timisoara in the framework of the research project European pre – Qualified steel JOINTS. Consequently, a numerical pretesting program was developed and carried out for the evaluation of

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