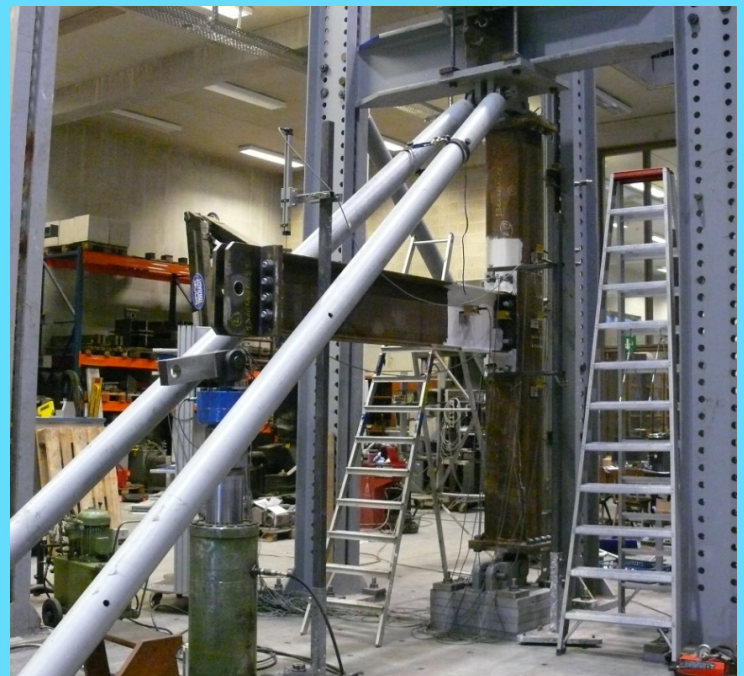


## International Workshop

# ***“HSS-SERF” - High Strength Steel in Seismic Resistant Structures***

**28-29 June 2013, Naples, Italy**



**ECCS  
CECM  
EKS**

# **International Workshop** ***High Strength Steel in Seismic*** ***Resistant Structures***

**28-29 June 2013, Naples, Italy**

***Organised by,***



***University of Naples "Federico II"***  
***Department of Structures for Engineering***  
***and Architecture***

***and***



***"Politehnica" University of Timisoara***  
***Department of Steel Structures and***  
***Structural Mechanics***

***in cooperation with***



**ECCS**  
**CECM**  
**E K S**

***European Convention For Constructional***  
***Steelwork***  
***(Committee TC13 "Seismic Design")***

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## 1. SCOPE AND OBJECTIVE OF HSS-SERF WORKSHOP

The International Workshop on High Strength Steel in Seismic Resistant Structures represents the Final Workshop of “HSS-SERF” – *High Strength Steel in Seismic Resistant Building Frames* – Research Project.

The workshop has the aim to present the outcome of the “HSS-SERF” research project, and to bring together the expertise of the ECCS technical committees TC13, TC11 and TC10. Last but not least, the workshop aims to provide a forum, with European researchers, for exchange of ideas in relation to the use of high strength steel in seismic resistant building frames.

## 2. MAIN TOPICS OF THE WORKSHOP

The main topics of the workshop are related to the use of high strength steel in seismic resistant building frames, and particularly to the following aspects:

- Technical regulation and methods of analysis
- Global system performance under static and dynamic loading
- Material performance and selection criteria
- Connections
- Execution technology
- Economic efficiency

## 3. TIME TABLE

		International Workshop High Strength Steel in Seismic Resistant Building Frames 2013 Naples, Italy	
		28 June 2013	29 June 2013
		Friday	Saturday
09:00 - 09:30	Registration of participants	Technical session (coffee break included)	
09:30 - 10:00	Opening. Introduction to HSS-SERF		
10:00 - 10:30	Coffee break		
10:30 - 11:00	Technical sesion		
11:00 - 11:30			
11:30 - 12:00			
12:00 - 12:30		Closing session	
12:30 - 13:00	Buffet Lunch	Buffet Lunch	
13:00 - 13:30	Technical sesion (coffee break included)		
13:30 - 14:00			
14:00 - 14:30			
14:30 - 15:00			
15:00 - 15:30			
15:30 - 16:00			
16:00 - 16:30			
16:30 - 17:00			
17:00 - 17:30			
17:30 - 18:00			
20:00	Dinner		

#### 4. VENUE

The Venue of HSS-SERF Workshop is represented by the Naples Seafront, Federico II Conference Centre, Via Partenope 36.



#### 5. TECHNICAL PROGRAM

The workshop is structured in two parts, presenting the research results obtained within “HSS-SERF” project, and respectively study and research results connected to HSS-SERF project topic obtained in Europe.

##### Workshop Technical Framework

- Research and normative needs for the new version of “EUROCODE 8” in the field of steel and composite structures – *Raffaele Landolfo*
- Objectives, summary of research activity in HSS-SERF project – *Dan Dubina*

##### Part I – Research results obtained within HSS-SERF project

###### **Seismic performance of dual-steel frame typologies**

- Seismic design of dual-steel structures – *Andre Tenchini, Mario D'Aniello, Carlos Rebelo, Raffaele Landolfo, Louis Simoes da Silva, Luciano Lima*
- Nonlinear analysis of dual-steel moment resisting frames – *Andre Tenchini, Mario D'Aniello, Carlos Rebelo, Raffaele Landolfo, Louis Simoes da Silva, Luciano Lima*
- Seismic performance of dual-steel concentric-braced frames in simple and dual configuration – *Mario D'Aniello, Francesco Portioli, Raffaele Landolfo, Andre Tenchini, Carlos Rebelo, Luis Simões da Silva*
- Seismic performance of dual-steel eccentric-braced frames in simple and dual configuration – *Mario D'Aniello, Giuseppe La Manna Ambrosino, Francesco Portioli, Raffaele Landolfo, Andre Tenchini, Carlos Rebelo, Luis Simões da Silva*

### **Ductility and strength demands of welded and bolted connections**

- Experimental analysis of dual-steel welded and bolted connections under monotonic and cyclic loading – *Andreas Kleiner, Ulrike Kuhlmann*

### **Tests on bolted beam-to-column joints in dual-steel frames of composite steel-concrete columns**

- Innovative bolted beam-to-column joints in moment resistant building frames: from experimental tests to design guidelines – *Hoang Van-Long, Jean-François Démonceau, Jean-Pierre Jaspart*

### **Tests on welded beam-to-column joints in dual-steel frames of composite steel-concrete columns**

- Evaluation of cyclic tests on welded stiffened beam-to-column joints in frames with HSS columns – *Blaz Cermelj, Darko Beg*
- Numerical parametric analysis on welded stiffened beam-to-column joints in frames with HSS columns – *Blaz Cermelj, Darko Beg*
- Experimental evaluation of the steel-concrete connection in case of concrete filled rectangular hollow section (CF-RHS) columns – *Cristian Vulcu, Aurel Stratan, Adrian Ciutina, Dan Dubina*
- Experimental evaluation of welded reduced beam section (RBS) and cover plate (CP) beam-to-CF-RHS column joints – *Cristian Vulcu, Aurel Stratan, Adrian Ciutina, Dan Dubina*
- Numerical investigation of welded RBS and CP beam-to-CF-RHS column joints – *Cristian Vulcu, Aurel Stratan, Adrian Ciutina, Dan Dubina*

### **Conceptual and performance based design (PBD) of dual-steel building frames under seismic actions: design recommendations**

- Panel Discussion: Performance objectives and criteria for the performance based design of dual-steel frame structures



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**Part II – Study and research results connected to HSS-SERF project topic obtained in Europe**

- Pre-test numerical simulations and experimental program on dual eccentrically braced frame with removable links – *Aurel Stratan, Adriana Ioan, Dan Dubina, Fabio Taucer, Martin Poljansek*
- Influence of material properties on the seismic performance of steel and steel-concrete structures – *Aurelio Braconi, Silvia Caprili, Hervé Degee, Max Guendel, Mohammed Hjaij, Benno Hoffmeister, Spyros Karmanos, Valerie Rinaldi, Walter Salvatore*
- Strain-rate sensitivity of steel members in seismic resistant buildings – *Marco Peroni, Paolo Negro*
- Theoretical and experimental analysis of T-stubs with four bolts in a row – *Luís Simões da Silva, Massimo Latour, Gianvittorio Rizzano, Aldina Santiago, Stefania Trezza*
- Yield and ultimate rotations of beam-to-column end-plate joints – *G. Terracciano, G. Della Corte, G. Di Lorenzo, R. Landolfo*
- Numerical investigation on bolted dual-steel T-stub under monotonic and cyclic loading – *Ana-Maria Pop, Daniel Grecea, Adrian Ciutina*
- Testing and numerical modelling of high strength steel joints - *R Xiao, H Alsbaty, K Smith*
- Seismic behaviour of joints made of high strength steel tubular columns – *Nicola Tondini, Oreste S. Bursi, Manuel Fassin, Gabriele Zanon*
- Numerical assessment of the deformation capacity of steel members subjected to monotonic and cyclic loading – *Miguel Araújo, José Miguel Castro*
- The strategy of plastic mechanism control for a rational use of high strength steel in MR-frames – *Rosario Montuori, Elide Nistri, Vincenzo Piluso*
- Seismic response of steel frames with special dissipative devices – *F. D’Agostino, G. Brando, G. De Matteis*
- Remarks about centrically, eccentrically and buckling restraint bracing in seismic resistant structures – *Helmuth Köber, Bogdan Ștefănescu*
- Critical analysis of design criteria for seismic resistant CBF - *Vincenzo Macillo, Carmine Castaldo, Luigi Fiorino, Antonio Formisano, Beatrice Faggiano, Federico M. Mazzolani*
- Displacement-based seismic assessment of steel frames - *M. Ferraioli, A. Lavino, A.M. Avossa, A. Mandara*
- Numerical evaluation of the buckling behaviour of high strength steel cold-formed sections - *A. Formisano, F. Gamardella, R. Landolfo, F.M. Mazzolani*

## **6. SUMMARY OF HSS-SERF RESEARCH PROJECT**

“HSS-SERF” – High Strength Steel in Seismic Resistant Building Frames – is a European research project of the Research Fund for Coal and Steel. The partnership of the project is composed of two steel producers – RIVA (Italy) and RUUKKI (Finland), a research centre – VTT (Finland), as well as six universities – Univ. Federico II Napoli (Italy), Univ. of Pisa (Italy), Univ. of Stuttgart (Germany), Univ. of Ljubljana (Slovenia), Univ. of Liege (Belgium) and „Politehnica” Univ. of Timișoara (Romania) – as project coordinator. The scope and objectives, the research activities as well as brief results are further presented.

### **Project partnership**

**“Politehnica” University of Timisoara (UPT) – project coordinator**

**RIVA Acciaio S.p.A (RIVA)**

**Technical Research Centre of Finland (VTT)**

**University of Liege (ULG)**

**University of Stuttgart (USTUTT)**

**University of Naples "Federico II" (UNINA)**

**University of Ljubljana (UL)**

**Gabinete de Informática e Projecto Assistido por Computador Lda. (GIPAC)**

**Rautaruukki Oyj (RUUKKI)**

**University of Pisa (UPI)**

### **Scope and objectives**

The aim of the project was to investigate and evaluate the seismic performance of dual-steel building frames, realised from two different steel grades: Mild Carbon Steel (MCS) and High Strength Steel (HSS). Dual-steel structural systems, in which MCS is used in dissipative members while HSS is used in non-dissipative “elastic” members, can be reliable and cost efficient. The main outcomes of the project are related to coherent performance based design methodology and relevant design criteria for ductility and overstrength of members and joint components, as well as joint detailing rules.

The main objectives of the HSS-SERF research project were as follows:

- To find reliable structural typologies (e.g. moment-resisting frames, concentrically braced frames, eccentrically braced frames) and connection detailing for dual-steel building frames, and to validate them by tests and advanced numerical simulations;
- To develop design criteria and performance based design methodology for dual-steel structures using high strength steel;



- To recommend relevant design parameters (i.e. behaviour factor  $q$ , overstrength factor  $\Omega$ ) to be implemented in further versions of the seismic design code (EN 1998-1) in order to apply capacity design approach for dual steel framing typologies;
- To evaluate technical and economical benefit of dual-steel approach involving HSS;

### **Research activities & Working packages**

The research activities of the project were divided into several working packages. A brief presentation of the work packages and the containing tasks is further made.

#### **WP1 - Selection of structural typologies and design of optimised dual-steel multi-storey frames**

WP1 is related to the selection of structural typologies and design of optimised dual-steel multi-storey frames. The tasks covered by WP1 are related to: selection of structural typologies and pre-design of frames, performance based evaluation and final design of selected frames based on pushover analysis, and design of test specimens for joints.

#### **WP2 - Evaluation of seismic performance of typical dual-steel frame typologies**

WP2 is related to the evaluation of seismic performance of typical dual-steel frame typologies. The tasks covered by WP2 are related to: selection and pre-design of frames for parametrical study (see Figure 1), nonlinear time-history analyses of frames, performance based evaluation of ductility and over-strength demands, and evaluation of  $q$ -factors associated with different performance levels.

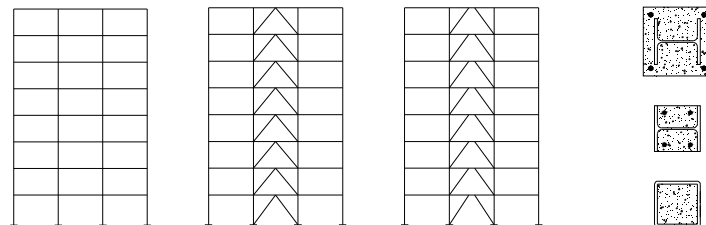


Figure 1. Structural typologies and cross sections used for columns

#### **WP3 - Qualification of welding for ductility and strength demands**

WP3 is related to the qualification of welding for ductility and strength demands. The tasks covered by WP3 are related to: experimental analysis of welded details and T-stubs (see Figure 2), interpretation and evaluation of results, and specifications for welding procedures to apply in fabrication of joint specimens.

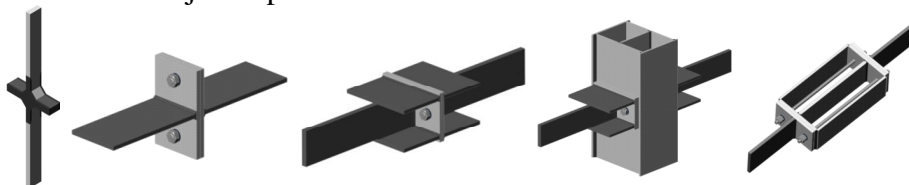


Figure 2. Welded details and T-stub typologies (Univ. Stuttgart)

#### WP4 - Prequalification tests on bolted beam-to-column joints in moment-resisting dual-steel frames

WP4 is related to the tests on bolted beam-to-column joints in moment-resisting dual-steel frames. The tasks covered by WP4 are related to: tests on bolted beam-to-column joints with partially-encased wide-flange columns (Figure 3a), tests on bolted beam-to-column joints with concrete-filled RHS columns (Figure 3b-c), and interpretation and evaluation of results.

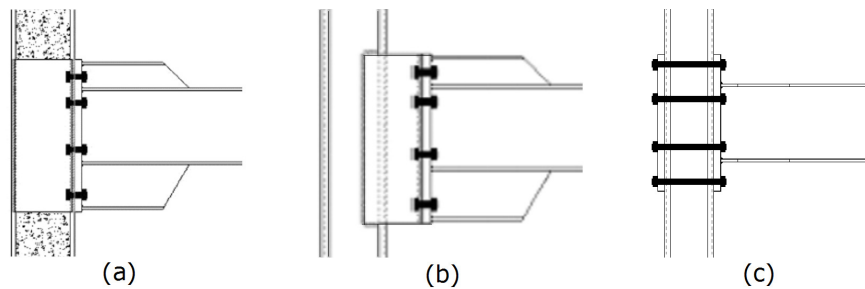


Figure 3. Bolted beam-to-column joint configurations (Univ. Liege)

#### WP5 - Prequalification tests on welded beam-to-column joints in moment-resisting dual-steel frames

WP5 is related to the tests on welded beam-to-column joints in moment-resisting dual-steel frames. The tasks covered by WP5 are related to: tests on welded stiffened and welded cover plate beam-to-column joints with fully-encased wide-flange columns (see Figure 4a), tests on welded reduced beam section and welded cover plate beam-to-column joints with concrete filled rectangular hollow section (CF-RHS) columns (see Figure 4b), and interpretation and evaluation of results.

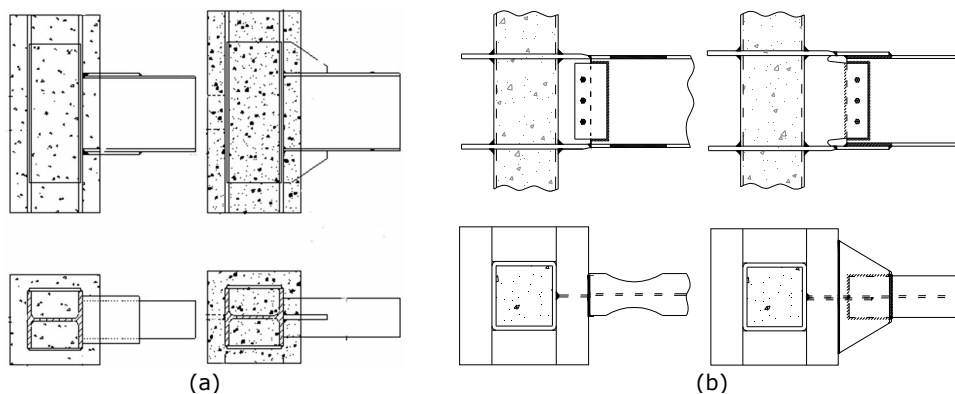


Figure 4. Welded beam-to-column joint configurations: (a) stiffened and cover plate joints with fully-encased wide-flange columns (Univ. Ljubljana), (b) reduced beam section and cover plate joints with CFT RHS columns (Univ. Timisoara)

#### WP6 - Guidelines for conceptual design and PBD of dual-steel building frames under seismic actions

WP6 is related to the development of guidelines for conceptual design and performance based design (PBD) of dual-steel building frames under seismic actions. The tasks covered by WP6 are related to: design and detailing rules for connections and joints, design methodology and

criteria for moment-resisting frames, design methodology and criteria for concentrically braced frames, and design methodology and criteria for eccentrically braced frames.

**WP7 - Evaluation of technical and economic efficiency of dual-steel structures vs. conventional ones**

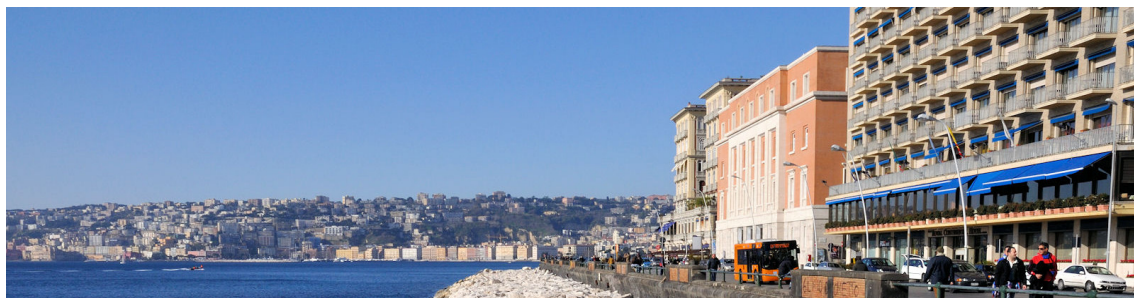
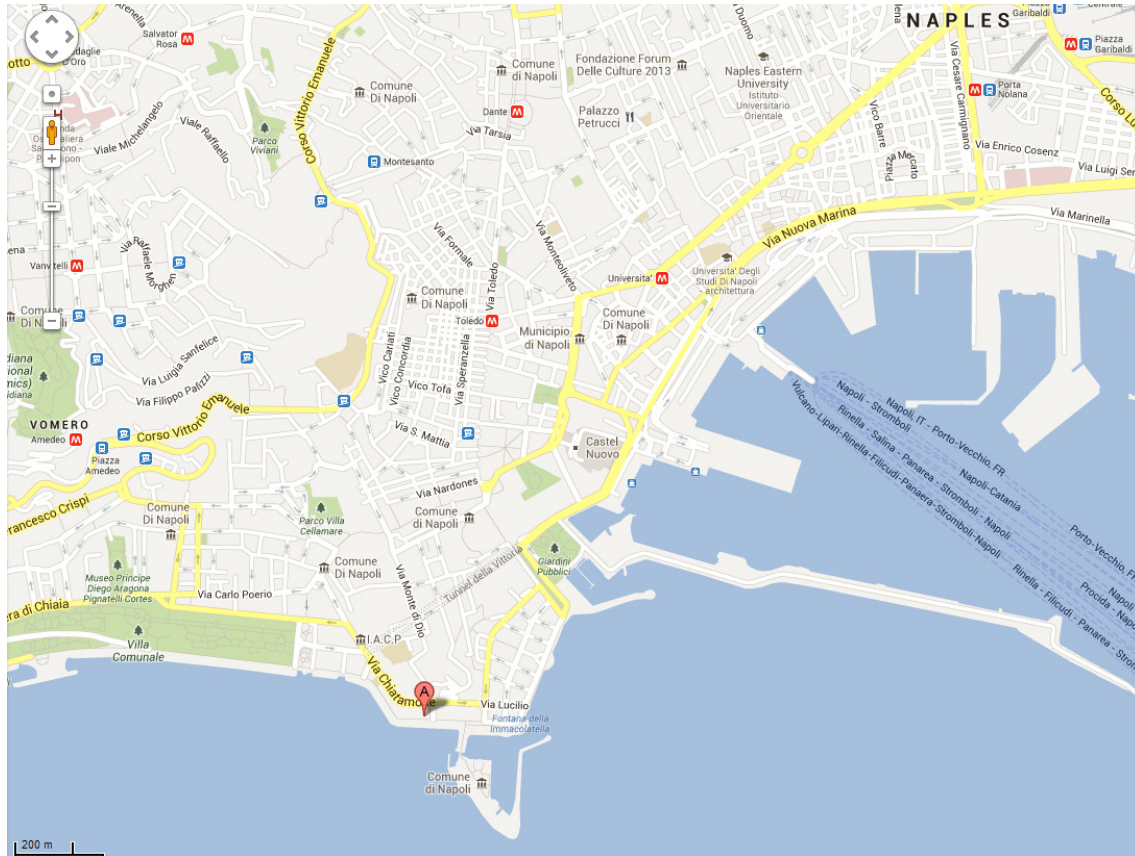
WP7 is related to the evaluation of technical and economic efficiency of dual-steel structures vs. conventional ones. The tasks covered by WP7 are related to: technical and economic efficiency of moment-resisting frames (study cases), technical and economic efficiency of concentrically braced frames (study cases), and technical and economic efficiency of eccentrically braced frames (study cases).

**WP8 – Coordination, management and dissemination**

WP8 is the final work package and is containing tasks related to: planning, coordination, progressive evaluation of the research, and dissemination of results.

## 7. WORKSHOP: LOCATION

**Meeting Place:** Naples Seafront, Federico II Conference Centre, Via Partenope 36.



## **8. CONTACT INFORMATION**

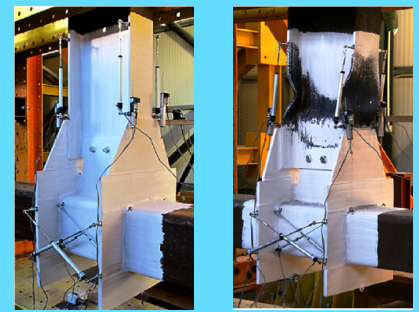
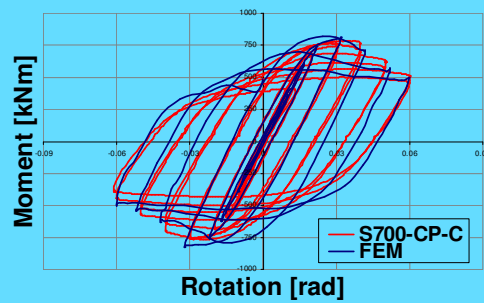
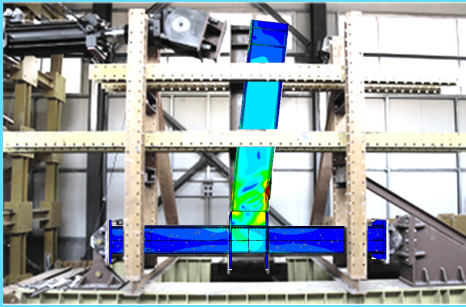
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## SCOPE AND OBJECTIVES OF THE WORKSHOP

The International Workshop has the aim to present the outcome of the “*HSS-SERF*” – *High Strength Steel in Seismic Resistant Building Frames – Research Project*, and to bring together the expertise of the ECCS technical committees TC10, TC11 and TC13. In addition, the workshop aims to provide a forum, with European researchers, for exchange of ideas in relation to the use of high strength steel in seismic resistant building frames.

## MAIN TOPICS OF THE WORKSHOP

The main topics of the workshop are related to the use of high strength steel in seismic resistant building frames, and particularly to the following aspects:

- Technical regulation and methods of analysis
- Global system performance under static and dynamic loading
- Material performance and selection criteria
- Connections
- Execution technology
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