Bulletin of the *Transilvania* University of Braşov
CIBv 2015 • Vol. 8 (57) Special Issue No. 1 - 2015

OBSERVATIONS REGARDING THE INTRODUCTION OF THE EUROPEAN STANDARD SR EN 1090 IN THE CURRENT PRACTISE OF THE STEEL HIGHWAY AND RAILWAY BRIDGES

E. Petzek [1] A. Feier [2] R. Băncilă [3]

Abstract: *The European Standard EN 1090-2 establishes all the rules that steel plants and execution companies have to implement in order to carry out a steel structure of good quality. It has three parts: SR EN 1090-1+A1:2012, SR EN 1090-2+A1:2012, and SR EN 1090-3:2008. The paper describes some case studies related to the application of EN 1090-2 in steel and bridge structures and the responsibility of the steel manufacturers, execution companies and designer. Some comments regarding the application in the current practice are presented.*

Key words: *execution class, CE marking.*

1. Introduction

The EU standard EN 1090 for structural steel and aluminum come into effect in July 2014. From this date, all components supplied into Europe will need to conform to this standard and be CE marked. This will have an important impact on all suppliers to this market, both large and small. There are three sections in SR EN 1090:

- SR EN 1090-1+A1:2012: Requirements for conformity assessment for structural components (CE marking) - [1];
- SR EN 1090-2+A1:2012: Technical requirements for the execution of steel structures - [2];
- SR EN 1090-3:2008: Technical requirements for the execution of aluminum structures- [3].

Related to EN 1090-1: 2009 + A1: 2011 „Execution of steel structures and aluminum structures Part 1: Requirements for conformity assessment of structural components” this first part provides guidance on the scope of structural components like structural steel and aluminums components, steel components used in composite steel and concrete structures and structural cold-formed

[1] SSF Romania, University of Politehnica Timisoara – Department of Steel Structure and Mechanic of Constructions
[2] INCD URBAN INCERC, Romanian Welding Association
[3] University of Politehnica Tmisoara – Department of Steel Structures and Mechanic of Constructions

members and sheeting's. The term "structural component" is defined in EN 1090-1 as: "Components to be used as load-bearing parts of works designed to provide mechanical resistance and stability to the works and/or fire resistance, including aspects of durability and serviceability which can be used directly as delivered or can be incorporated into a construction work". Components for use in Bridges are given in the same standard:

• Bridge refurbishment (where the work is done in the workshop and not on site)
• Footbridges (pedestrian and bicycle bridges)
• Sign and gantry girders
• Cable-supported bridges (Cable-stayed and suspension bridges)
• Bridges made from stiffened complex plate work (e.g. desk, box girders or arch boxes)
• Tension systems
• Moving bridges
• Bridges made from truss work
• Bridges made from plate girders
• Pipe bridges

Table 1 presents some typical examples of execution classes. EXC2 is the most common specification [4]. The execution class is determined by the designer and owner of the construction.

2. Principal Requirements

The characteristics, for which it is necessary to declare the performance SR EN 1090-1, are given in Figure 1. There are four execution classes (EXC1 to EXC4), with the number rising as complexity. The execution class determines the requirements for the various activities. For example, a handrail may be classified as EXC1 and a bridge EXC4. Works and can apply to an entire structure, parts of a structure or even to specific details. If no execution class is specified, EXC2 will apply even if the structure falls under EXC1.

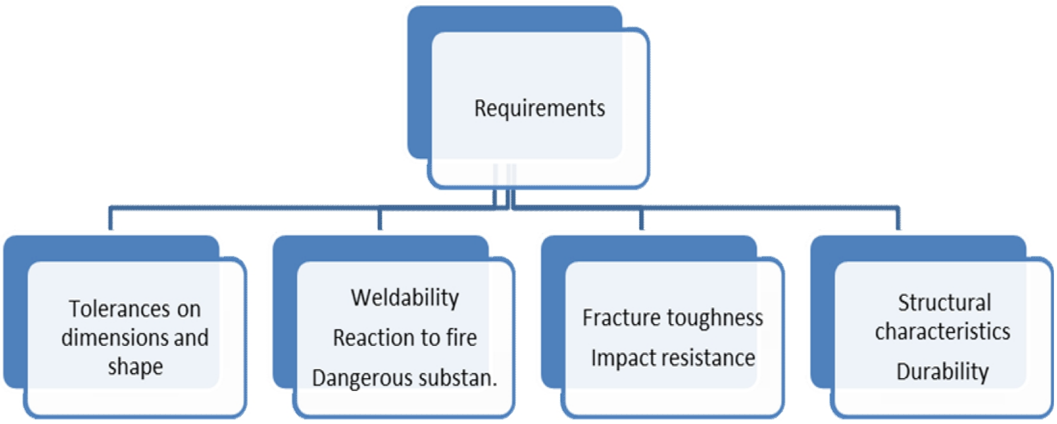


Fig. 1. *Principal requirements of SR EN 1090- 1*

Execution classes Table 1

EXC1	Supporting structures with steel up to strength class S275, buildings with up to 2 floors (4 floors if detached), bending beams up to 5m, projection beams up to 2m. Stairs & railings in residential buildings. Agricultural buildings, e.g. barns.
EXC2	Supporting structures with steel up to strength class S700. Buildings with 2–15 floors.
EXC3	Supporting structures with steel up to strength class S700. Assemblies/stadiums with large surface roof structures. Buildings with more than 15 floors. Pedestrian, bicycle, road and railway bridges. Crane track
EXC4	Bridges (road & rail) over densely populated areas or industrial plants with high hazard potential. Safety tanks in nuclear power plants.

To select the right execution class, the following three steps must be fulfilled:

Define the consequence class (Table 2). The aim of defining a consequence class is to ensure that structures are constructed with the appropriate level of quality control.

Consequence classes are based on building type, building height (number of storeys), floor plan area per storey (for retail) and occupancy.

A structure, or a part of it, could also consequence classes. In most cases, CC2 will be suitable.

Select a service category (Table 3).

Service categories reflect the risk arising from the actions to which these structure and its parts are likely to be exposed during erection and use (fatigue, seismic actions). The stress levels in the components in relation to their resistance are also taken in consideration. Usually SC1 will generally be appropriate.

Consequence Classes Table 2

Class	Description	Examples
CC3	High consequence	Stadiums and concert halls for 5,000+ people, buildings storing hazardous substances
CC2	Medium consequence	Most multi - storey residential and commercial buildings, hotels, hospitals, education establishments and car parks
CC1	Low consequence	Agricultural or storage buildings

Production category Table 3

Category	Criteria
PC1	• Non-welded components or welded components from steel grades below S355
PC2	• Welded components manufactured from steel grades from S355 and above • Components essential to structural integrity that are assembled by welding on the construction site • Components with hot forming manufacturing or receiving thermic treatment during manufacturing • Components of CHS lattice girders requiring end profile cuts

Using the above three criteria the execution class can be determined from Figure 2. Usually EXC2 will be applicable to Table 5 presents the technical knowledge most buildings. Where no execution class is specified, EXC2 applies.

Choice of the execution class is required by the welding coordinator, as specified in SR EN ISO 14731. The welding coordinator will be assessed by the notified body (in Romania – ISIM National Institute for Welding and Testing) – [5]. It is important to mention, that experience and knowledge of the relevant standards is more important than formal qualifications. EXC2, EXC3 and EXC4, require a welding coordinator.

Present in the factory or on site, this person is responsible for managing welding operations.

The recent introduced qualification of IWSD (International Welding Structural designer) is equivalent to IWE.

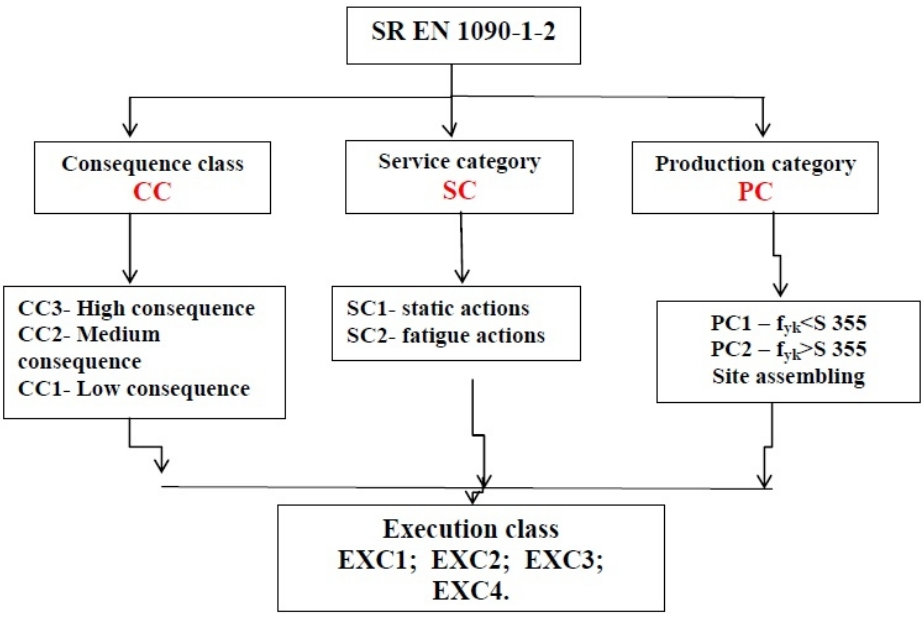


Fig. 2. *Choice of the execution class*

Technical knowledge required by the welding coordinator Table 4

Qualification and welding coordination according to IIW	
International Welding Engineer	**IWE** (Inginer Sudor Internaţional)
International Welding Technologist	**IWT** (Tehnolog Sudor Internaţional)
International Welding Specialist	**IWS** (Specialist Sudor Internaţional)

Finally the choice of the execution class can be done according to the recommendations from Table 5 – [6, 7].

Table 5 presents the necessary technical knowledge of welding coordinator.

Execution class versus qualification and welding coordination Table 5

Execution class versus qualification and welding coordination							
Consequence class		**CC1** **low**		**CC2** **medium**		**CC3** **high**	
Category		**SC1** Static actions	**SC2** Fatigue actions	**SC1** Static actions	**SC2** Fatigue actions	**SC1** Static actions	**SC2** Fatigue actions
PC1 **<** **S355**	t ≤ 25 (50*)	**EXC1**	**EXC2** IWS	**EXC2** IWS	**EXC3** IWT	**EXC3** IWT T	**EXC3** IWT
	25t ≤ 50 (75*)	**EXC1**	**EXC2** IWT	**EXC2** IWT	**EXC3** IWE	**EXC3** IWE	**EXC3** IWE
	t >50	**EXC1**	**EXC2** IWT	**EXC2** IWT	**EXC3** IWE	**EXC3** IWE	**EXC3** IWE
PC2 **S355**	t ≤ 25 (50*)	**EXC2** IWS	**EXC2** IWS	**EXC2** IWS	**EXC3** IWT	**EXC3** IWT	**EXC4** IWE
	25t≤ 50 (75*)	**EXC2** IWT	**EXC2** IWT	**EXC2** IWT	**EXC3** IWE	**EXC3** IWE	**EXC4** IWE
	t>50	**EXC2** IWE	**EXC2** IWE	**EXC2** IWE	**EXC3** IWE	**EXC3** IWE	EXC4 IWE
PC2 **>S35** **5**	t≤ 25 (50*)	**EXC2** IWT	**EXC2** IWT	**EXC2** IWT	**EXC3** IWE	**EXC3** IWE	**EXC4** IWE
	25t≤ 50 (75*)	**EXC2** IWE**	**EXC2** IWE**	**EXC2** IWE**	**EXC3** IWE	**EXC3** IWE	**EXC4** IWE
	t>50	**EXC2** IWE	**EXC2** IWE	**EXC2** IWE	**EXC3** IWE	**EXC3** IWE	**EXC4** IWE
*Column base plates and endplates **IWT adequate if grade N,NL,M,ML							

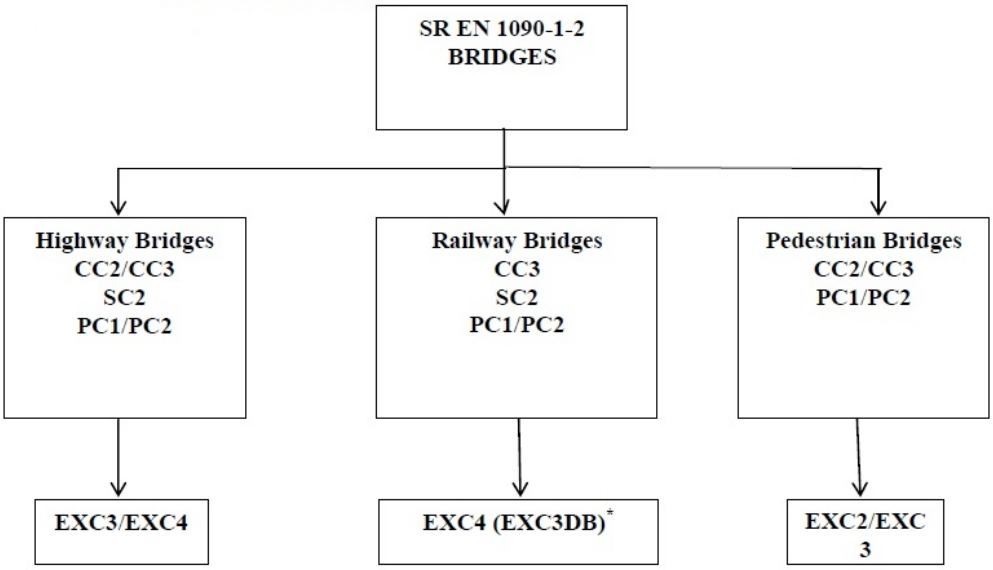


Fig.3. *Execution classes for bridges*
**Recommendation of the German Railway Company (Deutsche Bahn)*

It is important to mention that, for railway bridges the present concept can reduce the safety level; by choosing CC2 and SC2, it results the execution class EXC3.

From this reason the German Railways-Deutsche Bahn has introduced the execution class EXC3DB [8].

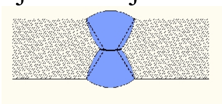
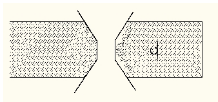
In Table 7 an excerpt from this standard is given.

In a similar way the German Highway Administration have they own rules [9]; they recommend the EXC3 class, with an amount of 50 % NDT, for butt welds.
Generally the extent of the NDT verifications is given in Table 8.

Excerpt from the DBS 918 005 Table 7

Element	Class Execution
• Railway bridges including auxiliary structures	**EXC3DB**
• Elements for noise protection	**EXC3DB**
• Bearings	**EXC3DB**
• Expansion joints	**EXC3DB**
• Handrails	**EXC2DB**

NDT verification Table 8

Extent of the NDT verifications			
Type of weld	Shop and site welds		
	EXC2	**EXC3**	**EXC4**
Transverse butt welds and partial penetration welds in butt joints subjected to tensile stress   U < 0.5 U ≥ 0.5	**10 %** **0 %**	**20 %** **10 %**	**100 %** **50 %**
Transverse butt welds and partial penetration welds: • In cruciform joints • In T joints	**10 %** **5 %**	**20 %** **10 %**	**100 %** **50 %**
Transverse fillet welds in tension or shear: With a > 12 mm or t > 20 mm With a ≤ 12 mm and t ≤ 20 mm	**5 %** **0 %**	**10 %** **5 %**	**20 %** **10 %**
Longitudinal welds and welds to stiffeners	**0 %**	**5 %**	**10 %**
• Longitudinal welds are those made parallel to the component axis. All the others are considered as transverse welds. • U = Utilization grade for welds for quasi-static actions. U = Ed/Rd, where Ed is the largest action effect of the weld and Rd is the resistance of the weld in the ultimate limit state. • Terms a and t refer respectively to the throat thickness and the thickest material being joined			

Many situations are not clear defined. As an example, if we take one railway bridge in steel composite structure - a modern solution that is based on prefabricated elements type VFT [10] classified as class implementation under from Annex B of SR EN 1090-2 the execution class is selected based on the following criteria:

• High consequences as casualties and huge economic significances leading to a high level –it results CC3;

• Fatigue, which leads to a service category SC2;

• Steel grade 355 resulting PC2.

According to these parameters from Table 5, it results EXC 4. The German Railways-Deutsche Bahn, respectively German Institute of Construction Engineering DIBt recommend in the same situation EX3.

3. Conclusions

- Choice of the execution class in the future in accordance with Annex X of EN 1993 in place of Annex B, EN 1090-2.
- An easier approach to ensure a higher degree of understanding and transparency is necessary.
- Also in this respect to eliminate some uncertainties clear links between SR EN 1090-2 and SR EN 1991-1-7 must be done.
- Execution class EXC4 can be chosen only in exceptional cases.

References

1. *** SR EN 1090-1+A1:2012: *Requirements for conformity assessment for structural components (CE marking);*
2. *** SR EN 1090-2+A1:2012: *Technical requirements for the execution of steel structures;*
3. *** SR EN 1090-3:2008: *Technical requirements for the execution of aluminum structures.*
4. *** *http://www.lindegas.com/ EN_1090_White_paper17_119019.pdf.*
5. Z. Ieremici, M. Oproiu *”Cerințe pentru evaluarea conformității și cerințe tehnice pentru execuția structurilor de oțel și aluminiu conform SR EN 1090”* Revista Sudura, XXI, 3 / 2011.
6. Radu D., Feier A., Bancila R., (2015) *Dezvoltarea sustenabilă și reabilitarea construcțiilor metalice sudate existente, 22-25 APRILIE Conferinta de la Arad a Asociatiei de Sudura din Romania*
7. SAT EN 1090-*proiect european desfasurat prin Asociatia de Sudura din Romania.*
8. *** *Deutsche Bahn „Ausführung von Eisenbahnbrücken“DBS 918005,* August 2012.
9. *** *Bundesanstalt für Straßenwesen „Zusätzliche Vertragsbedingungen und Richtlinien für Ingineurbauten” ZTV-ING,* Teil 4, Stahlbau, Stahlverbundbau 12/2012.
10. E. Petzek, R. B Băncilă,: *Economical Bridge Solutions based on innovative composite dowels and integrated abutments*, Springer Verlag, 2014, ISBN 978-3-658-06416-7.
11. Feier A., Petzek E., Hernea S,. (2015) *Life Prediction in Two Types of Cracks at Eye-Bars of the Cantilever Bridges, Structural Integrity of Welded Structures XI, Advanced Materials Research*
12. Feier A,. (2015) *Effect of Corrosion and Cracks at the Historical Steel Bridges, Structural Integrity of Welded Structures XI, Advanced Materials Research,*
13. Hernea S., Boldus D., Feier A,.(2015) *Application of Fracture Mechanics to Determine the Remaining Lifetime of the Old Steel Bridges Decks, Structural Integrity of Welded Structures XI, Advanced Materials Research.*

Erasmus+

SAT-EN1090
Requirements for Steel & Aluminium Structures