Understanding Compliance in Structural Steel

EN 1090 and Eurocodes
Practical Information for Designers

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Engineers Ireland 23rd April 2015
Legislative Background


2. S.I. 225 of 2013 (European Union (Construction Products) Regulations 2013) facilitates implementation e.g. delegation of surveillance to Building Control authorities.


4. Part D Building Regulations “Material and Workmanship” amended 2013. Specific attention to CPR defines “proper materials”. CE Marking in accordance with the CPR. For steel CE marking since 1 July 2014.

5. Part A Building Regulations “Structure”: 2012 TGDA refers to and is based on Eurocodes.
I.S. EN 1990 Basis of Structural Design

Clause 1.3(2) The general assumptions of EN 1990 are:

- the choice of the structural system and the design of the structure is made by appropriately qualified and experienced personnel;

- execution is carried out by personnel having the appropriate skill and experience;

- adequate supervision and quality control is provided during execution of the work, i.e. in design offices, factories, plants, and on site;

- the construction materials and products are used as specified in EN 1990 or in EN 1991 to EN 1999 or in the relevant execution standards, or reference material or product specifications;

- the structure will be adequately maintained;

- the structure will be used in accordance with the design assumptions.

NOTE There may be cases when the above assumptions need to be supplemented.
Construction Products Regulations

Essential Requirements

1) Mechanical resistance and stability
2) Safety in case of fire
3) Hygiene, Health and the Environment
4) Safety in use
5) Protection against noise
6) Energy economy and heat retention
7) Sustainable use of natural resources  new in CPR
Construction Products Regulations

Came into force 1 July 2013

For steelwork CE marking obligatory since 1 July 2014

Declaration of Performance required (DoP)

This has to be supplied by manufacturer, in case of fabricated structural steel, this means the fabricator.

Requirements for Manufacturer, Draw up DoP, Affix CE mark, documentation, safety instructions, rectification of non-conforming products

Requirements for Distributors, check what manufacturer has done, documentation, appropriate instructions, check NAs etc etc

Requirements for Importers, check compliance of product, documentation, check NAs etc

Requirements for specifier, designers or builders, refer to hENs, review DoP, check National Annexes etc, refer to BRegs
Steel Execution Standards

I.S. EN 1090 Execution of Steel and Aluminium Structures
Part 1: 2009 Requirements for conformity assessment of structural components
Part 2: 2008 Technical requirements for steel structures
Part 3: 2008 Technical requirements for aluminium structures


“Eurocode 3: Design of Steel Structures – Part 1-1 General rules and rules for buildings”

Also FprA1: 2013 recent amendment to Eurocode dealing with execution

Note There are also execution standards for concrete I.S. EN 13670 and for some geotechnical areas. There may be more for other materials in the future.
FprA1: 2013  Modification to National Annex

The principal addition is a new Annex C “Selection of execution class”

This is a normative annex which must be used and defines Execution Class (EXC) as a classified set of requirements for the works as a whole, an individual component or a detail of a component.

C1.2  4 execution classes ranging from EXC1, low, to EXC4, most onerous.

EN 1090-2 states use EXC2 if no other execution class is specified.

C2.1  Select EXC based on:

- Required reliability
- Type of structure component or detail
- Type of loading for which the structure is designed

C2.2  For reliability management, select based on Consequences class (CC) or reliability class (RC) or both.

For loading, base EXC on whether actions are static, quasi-static, fatigue, seismic

Use Table C.1
### Table C.1

<table>
<thead>
<tr>
<th>Reliability class (RC) or Consequences class (CC)</th>
<th>Type of loading</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Static, quasi-static or seismic DCL&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>RC3 or CC3</td>
<td>EXC3&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>RC2 or CC2</td>
<td>EXC2</td>
</tr>
<tr>
<td>RC1 or CC1</td>
<td>EXC1 or EXC2&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

- **a)** Seismic ductility classes are defined in EN 1998-1:- low DCL, medium DCM and high DCH. Ireland DCL.
- **b)** Fatigue see EN1993-1-9
- **c)** EXC4 may be used for structures with extreme consequences of structural failure
- **d)** See C.2.2(4)

Note: Designs to EN 1993-4-1 and -4-2, (Silos and Tanks), may depend on CC, while designs to EN 1993-3-1 and-3-2, (Towers, masts and chimneys), may depend on RC.

This table is different in terminology to the tables in EN 1090-2. The code drafters will have to rationalise this at some stage but from a designer’s viewpoint EN 1993 will take precedence.
In Ireland there will be a modified NA “Selection of Execution Class”

NA.2.26 Subclause C.2.2(3) Selection of execution class

“The selection of execution classes may be based on reliability classes or consequences classes or both. It is recommended that Table C.1, with the following exceptions, should be used to aid the selection of the most appropriate execution class for the structure, component or detail:

- EXC2 should be the minimum execution class for all dwellings and residential units,
- Execution classes for bridge works shall be taken from the project specification.”


Engineer must specify Execution Class
FprA1: 2013 Modification to National Annex

UK position

A draft PD 6695-1-1 “Recommendations for the design of steel structures to BS EN 1993-1-1” is being developed.

Explains background – users to make decisions that affect the target level of reliability.

Reliability Management principles given in EN 1990 clause 2.2

Steps can be taken at all stages: design, execution, use and maintenance.

Reliability class is given in Annex B (informative) of EN 1990.

Reliability class related to Reliability Index which relates to probability of failure of approx 1 in 10,000 in a 50 year lifetime.

There are higher and lower classes.

These relate to inherent deviations in actions or resistances

NOT to gross human error - gross deviations
FprA1: 2013  Modification to National Annex

Annex B EN 1990

Control measures

Design Supervision levels, DSL1, DSL2 and DSL 3 relating to RC1, 2 or 3 respectively

1. Self checking,
2. normal supervision usually within same organisation and
3. third party checking.

Inspection levels during execution, IL1, IL2 and IL3 again relating to RC1, RC2 and RC3.

1. Self inspection
2. Inspection according to the organisation’s procedures and
3. Third party inspection.
Consequences Classes
Also defined in TGD A: 2012, section 2, Table 6.
Consequences classes are defined in terms of loss of human life and also economic, social or environmental consequences.
Interpretation is quite subjective.
TGD A section 2 relates to disproportionate collapse and gives rules for tying of structures. This applies to all materials.

The new annex C of EN 1993-1-1, as set out in FprA1:2013, refers to selection of execution class for obtaining reliability.
Execution classes come not from the Eurocodes, (TC 250) but from steel industry standards, (TC135) especially EN 1090-2.
Annex B to EN 1090-2 has three tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Service categories, depends on loading e.g. seismic or fatigue,</td>
</tr>
<tr>
<td>B2</td>
<td>Production categories e.g. grade of steel, welding etc.</td>
</tr>
<tr>
<td>B3</td>
<td>Combines these with Consequences classes to give the Execution class</td>
</tr>
</tbody>
</table>

The requirements for each execution class are defined in Annex A of EN 1090-2 and also Table 1 of main text which specifies what documentation is required for each class.

These have been changed, editorially and technically to a degree, in the new annex C of EN 1993-1-1.
Execution class (EN 1090-2) can vary from EXC1 (low) to EXC4 (high)

**Execution Class** – depends on consequence class or reliability class and type of loading (EN 1990/EN 1991)

Execution class - depends on Consequences class, service category (loading) and production category (EN 1090-2).

Can be either for:
- execution of works as a whole
- an individual component
- detail of a component

Client / Main Contractor must appoint a steelwork sub-contractor certified for an Execution Class at least equal to the requirement for the structure, component or detail

Steel contractors need for CE Marking/Certification
- Factory Production Control (FPC) Certificate *(from Notified Body)*
- Welding Certificate *(from Notified Body)*
- Declaration of Performance *(provided by Steelwork Contractor)*
- These will be certified for particular execution classes
Designers / Specifiers need to
- Refer to harmonised technical specifications
- Check National Annex and Eurocodes,
- Client’s specifications e.g. NRA, if applicable
- Comply with Building Regulations
- Specify required execution class based on design requirements of element

**Execution class is a design issue**

Clause 3 of the Building Regulations “proper materials” should bear CE Marking....

Note:

Building Control (Amendment) Regulations certificates refer to Building Regulations
NRA Specification series 1800 and Guidance NG 1800 generally EXC 3
Designers / Specifiers

EN 1090-2  Project Specific requirements

Annex A  Table A1  Additional requirements needed to be specified
  Table A2  list of options
  Table A3  requirements relating to execution classes

Various requirements e.g. Specification, documentation, products used, preparation and assembly, welding, fastening, erection, surface treatment, tolerances, inspection etc.

4 Execution classes
EXC 1  Farm buildings
EXC 2  most buildings including houses Irish NA
EXC 3  Bridges, CC 3 buildings
EXC 4  Special structures

If Fatigue an issue, this may modify class.
In Ireland there will be a modified NA “Selection of Execution Class”

NA.2.26 Subclause C.2.2(3) Selection of execution class

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Engineer must specify Execution Class
Action by Engineers

- Amend specifications to cover this
- Provide execution classes for all components, structures or special details
- Do not over specify Execution classes, most buildings will be EXC2, bridges EXC3 but engineer needs to review.
- Inform client and rest of design team
- Notify all parties; client and contractor responsible
- Check steel contractors status
- Get DoP for steel elements
- Maintain records

For some projects legal and/or insurance advice may be needed
Risks

1. Penalties and Fines S.I. 225 of 2013
2. Responsibility for demonstrating compliance with CPR and hENs rests with manufacturer of the product with obligations also on importers and distributors
3. Failure of structure, unlikely but quality of fabrication important
4. Prior to commencement engineer should ensure fabricator certified to appropriate execution class, make other parties aware of need,
5. Engineer should not appoint steel sub-contractor,
6. Risk of delay/cost increases if problem arises
7. Could Building Control Authority act and state Fabricator not suitable?
8. Can certification in line with BC(A)R be given if fabricator not certified?
9. Risks after completion if something goes wrong
Conclusions

- This is not in itself an engineering problem but engineers need to be aware of these issues and how it affects them and their work.
- This is also an administrative issue under the contract.
- There are many interested stakeholders - Clients, Contractors, Steelwork Fabricators, design team members, government bodies, CIF.
- Each party will have their own concerns.
- It is important for the steel industry that contractors are fully aware of their responsibility and that they need the appropriate qualifications for the work being carried out. Steel contractors with a EXC 1 certificate may only be suitable for farm buildings.
- A list of qualified fabricators should be available for each EXC class.
- It is probable that these requirements will be refined further as experience develops with both the Eurocodes and the Execution standards.
Reference List

- S.I. No. 225 of 2013 European Union (Construction Products) Regulations 2013
- Information note on the Construction Products Regulations, BRAB
- Building Control (Amendment) Regulations, S.I. 9 of 2014
- Materials and Workmanship, Part D of the Second Schedule of the Building Regulations:2013 Department of the Environment, Community and Local Government
- Steel Construction CE Marking, Tata Steel and BCSA, August 2013
- CE Marking, Steelconstruction.org website
- I.S. EN 1090-1 Execution of Steel structures and aluminium structures –Part 1: requirements for conformity assessment of structural components, NSAI
- I.S. EN 1090-2 Execution of Steel structures and aluminium structures –Part 2: Technical requirements for steel structures, NSAI
- I.S. EN 1090-3 Execution of Steel structures and aluminium structures –Part 3: Technical requirements for aluminium structures, NSAI

- Irish NAD for EN 1993-1-1:2005 +A1, NSAI to be approved and issued.
- PD 6695-1-1 “Recommendations for the design of steel structures to BS EN 1993-1-1” at present only in draft form
- PD 6705-2:2010 “Recommendations for the execution of steel bridges to BS EN 1090-2”
- TGD D Materials and Workmanship Building Regulations 2013, Department of the Environment, Community and Local Government
- Ancillary Certificates, ACEI, Engineers Ireland, SCSI and RIAI: 2014
- NRA Specification for Road Works Volume 1, series 1800 Structural Steelwork
- NRA Specification for Road Works Volume 2, series NG 1800 Structural Steelwork
- Irish Notification Procedures for the purposes of the Construction Products Regulation, (305/2011) Department of the Environment, Community and Local Government
- There are other sources available for information such as BCSA, Engineers Ireland seminars and many other places.