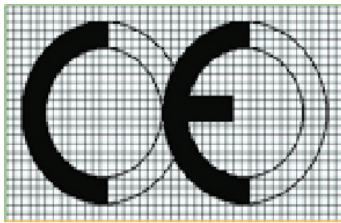


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## EN standard 14933 for EPS in Civil Engineering Applications (CEA)

Hans Tepper discusses the work involved in developing EU standards for EPS-based construction projects.

Below: CE product standard logo



In 1990 the European Union introduced the 'Construction Products Directive' (EC 89/106) with the aim of promoting free trade in the EU for construction products. According to EC 89/106, harmonised product standards had to be developed for a series of products. These standards needed to include material properties, test methods and a chapter on the evaluation of conformity. The idea was that standardisation would promote free trading, with the resulting 'CE' mark acting as a trading 'passport'. A proviso to the regulation is that performance requirements had to be set locally as a result of national building regulations and building methods. The act of translating performance requirements into product properties therefore acted as the 'visa' for these products.

It took ten years to develop product standards for insulating materials, the test methods and the conformity standard. In 1999 a TF was set up to translate the insulation standard into a product standard for expanded polystyrene (EPS) in civil engineering applications. This work is now finished and the results are now communicated.

The most important difference between all the existing standards or guidelines for EPS blocks in civil engineering applications is that density is no longer a requirement. Rather, density is used only an aid for internal quality assurance (QA) because other properties – required for the end use application – can be achieved irrespective of the density. This means that the insulation industry can develop product types meant especially for specific applications. This enables product innovation and expands the possibilities for the application of EPS.

The requirements in the newly developed standard are set in terms

of levels or classes for general applications (mandatory) and specific applications. In this paper these properties will be explained. In addition the evaluation of conformity that completes the standard is addressed. Special attention is also paid to long term compressible behaviour (creep) and long term strength properties.

As the application of EPS in civil engineering projects expand there is a need for a standard for blocks and thick boards. The existing standard for building insulation provides the necessary basics. However, typical differences between existing standards in the EU and the building insulation standard make the 'block' standard a separate one, to be judged on its own.<sup>1</sup> It should be noted that after thorough discussion in the Nordic part of Europe, an extra dynamic stability test was added for railroad applications.

### Field of application

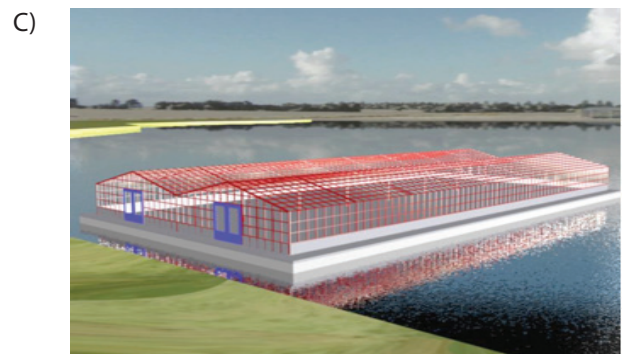
In the last decade the possible applications of EPS has increased dramatically. Nowadays almost any possible EPS-based construction can be realised, such as;

- Light-weight fill and frost insulation;
- Bridge abutments;
- 'Green' houses.

### EU product standards

The objective of the 1990 Construction Products Directive (CPD), was to champion free trade of construction products between member countries of the EU.<sup>2</sup> The EU

Below and right: Applications of EPS: a) light-wieght fill and frost insulation; b) bridge abutments; c) 'green' houses



mandated CEN (Commission Européenne de Normalisation) to create product standards and test methods for this purpose. CEN TC 88 and CEN TC 89 were established for insulating materials and calculation rules respectively.

In CEN TC 127 'Road Materials' it was discovered that 'Geofoam' standards were not incorporated in the scope of their technical committee (TC) and thus TC 88 was asked to provide these standards based on their experience and expertise.

The EPS industry felt a need for standardisation of CEA blocks to improve the transparency in competition and to provide authorities, consulting engineers and contractors with a system of levels and classes for product properties and their test methods. This enables designers to develop EPS applications that suit fully the demands and – from the integral approach of capitalising initial and maintenance costs – gives optimal price and performance solutions.

It is due to the co-operation between industry, consultants, standardisation bodies and authorities that this project was set up. At the same time the extruded polystyrene (XPS) industry also started a similar project. Both were mandated by the EU to CEN.

**CE marking, labelling and designation code**

Products that fulfil the requirements of the harmonised product standard are allowed to be marked 'CE'. This CE-marking acts as a 'passport' for free trade between EU-borders. However the application has to fulfil local building requirements, for example compressibility, structural stability, creep, etc. An example of a frame for CE marking is given in Table 1.

<p>CE</p> <p>Number of notified body (for products under system 1)</p>
<p>Name or identifying mark and registered address of the manufacturer or his authorized representative established in the EEA.</p> <p>Two last digits of year of affixing CE marking. Number of EC certificate of conformity (where appropriate).</p>
<p>EN number of product standard Product identity Reaction to fire – Class Thickness Designation code (in accordance with clause 6 of the standard for the relevant characteristics according to table ZA.1).</p>

**Composition of the standard**

The 'EPS in CEA' product standard contains a list of properties to be declared by the manufacturers on the basis of validated test methods. For tolerances deemed as 'zero', classes were introduced to be able to deliver blocks for lightweight fill that will never be in a 'loaded' application, e.g. where the loads of plants, trees and foot traffic can be neglected.

The requirements on dimensional stability – a product property to avoid excessive shrinking after production – are equal to that for thermal insulation applications. This enables QA to be set up with fewer different specifications.

From the requirements for all applications the declaration of compressive stress of 10% is the most important issue and must meet the requirements of EN 826. Depending on the type of application and the performance requirements this will be set accordingly. For specific applications like in roads and railroads, e.g. in Scandinavian countries, compressibility at 2% or 5% is needed.

**Below:** Table 1 - relationships between compressive stress and designation value for EPS

Compressive stress at 2% (kPa)	Compressive stress at 5% (kPa)	Designation value, stress at 10% (kPa)
40	50	60
60	90	100
100	120	150
150	200	250

Note that for a light density product and a relatively low requirement this may be in the elastic part of the stress/strain curve. The pressure requirement at 10% deformation is meant for designation purposes and not for an application-related requirement. Nevertheless it fills the gap between building insulation QA and that of QA for blocks for CEA.

The EN standard EN 826 allows for the determination of compressive stress at any deformation. Calculation rules for the E modulus over the elastic part of the stress/strain curve are also given in Table 3. The ratio between the declared levels for 2%, 5% and 10% is about 0.60, 0.90 and 1.00, this being the normal relationship for a specific EPS-type product.

Bending strength has a minimum requirement of 50kPa for handling purposes in all applications; for specific applications this could be increased by the designer.

For specific applications the consultant is free to set requirements. Moreover, if it is not required the producer does not need to determine and therefore does not need to declare these limits. This is valid for:

- dimensional stability under specific conditions;
- bending strength;
- compressive creep;
- thermal conditions;
- water absorption;
- freeze/thaw resistance;
- resistance to cyclic loading.

**Left:** An example of a typical CE marking certificate

For all these requirements a table is given in which the test methods, number of test specimens and conditions are combined.

**Testing**

In principle all product properties have to be measured by direct testing. However, it is possible to use density as a means to decrease costs of internal QA when standard curves are used. These standard curves are based on European data gathered over the last 25 years. This allows for a prediction of compressive stress at 10% and thermal conductivity in relation to density for consultants. The relationship between density and compressive stress is then provided in a subsequent appendix.

**EPS product types**

EPS products are divided into types based on compressive and bending strengths. Each type shall satisfy the two different conditions at the same time in order to ensure adequate product performance. Only if the classification requirements given in that table are fulfilled, as well as additional properties given in an appendix will the standard be applied.

**Additional properties and creep**

In an informative appendix to the standard a correlation between bending strength and shear strength is given. Information relating to compressive creep and water vapour diffusion resistance and permeability is also available. EPS products meeting the requirements as set out in Figure 5 are expected to have a compressive creep deformation of 2% or less after 50 years, when subjected to a permanent compressive stress of  $0.30\sigma_{10\%}$ .<sup>3</sup>

**Below:** Table 2 - Overview of stresses and E-modulus labelling

Type of EPS	EPS 60	EPS 100	EPS 150	EPS 250
Long term strength	18	30	45	75
Bending strength	100	150	200	350
E-modulus	4000	6000	8000	12,000

**Right:** Further examples of EPS applications: innovative housing projects (above) and insulating blocks (below)

Compressive creep in reality will be less than predicted by testing small samples due to stiffening of the matrix and the volume effect of the blocks used. With this designers are able to connect other relevant product properties to a chosen product type.

The designation strength at 10% deformation is in fact the short-time breaking strength (the test is performed in minutes). In order to derive the long term-permissible stress arbitrarily in most countries a value of  $0.30\sigma_{10\%}$  is applied and then multiplied by a material factor  $\gamma_m$ , connected to 2% creep.

The material factor is to be derived from Eurocodes or national application documents. Thus the total deformation at  $0.30\sigma_{10\%} = 2\% + 0.5 = 2.5\%$ .

**Resistance to cyclic loading**

The resistance to cyclic loading shall be determined either in accordance with the existing test as described in EN 29052-1 or in accordance with a method given in Appendix D, derived from the Swedish standard SP 2687.<sup>4</sup> In the latter case no test result shall exceed 5% permanent deformation after  $2 \times 10^6$  load cycles with load levels of 100, 200 or 300 kPa respectively.

**References**

1. CEN TC 88 EN 14933 EPS in CEA standard.
2. Construction Products Directive (CPD), EC 89/106, Brussels 1990.
3. L. C. E. Struik, "Physical aging in amorphous polymers and other materials", Elsevier Scientific Publishing, 1978.
4. SP 2687, "Determination of the resistance to cyclic compressive loading", Boras (SE), 2001.

**Acknowledgements**

Several years of hard labour and discussion requires the author to thank the Task Force members for their valuable contribution. In no particular order; Rolf Fagervoll (Sunde, Norway); Roald Aaboe (NRRL, Norway); Inge Brorsson (SGI, Sweden); Simon Hoikkala (FINFIP, Finland); Osmo Anttila (FRA, Finland); Frieder Hohwiller (BASF, Denmark); Erik Thelberg (Sundolitt, Sweden) and six corresponding members under the convenorship of the author. For the necessary coordination with the 'sister' standard for XPS in CEA the author would like to thank Horst Wirgailis and Gerard Curtenat from DOW. 