EUROPEAN STANDARD FOR EPS IN CIVIL ENGINEERING APPLICATIONS (CEA)

Tepper, H. [1]

ABSTRACT

In the European Union in 1990 the "Construction Products Directive" (EC 89/106) was accepted aiming free trade in the EU for Construction products. For a series of products harmonised product standards had to be developed, containing at least material properties, the test method and a chapter on evaluation of conformity thus enabling CE marking on the product. With this free trade would be possible (CE marking acting as "passport"). Performance requirements have to be set locally as a result of Building Regulations and building methods. The translation scheme of performance req's into product properties act 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 EPS in Civil Engineering Applications. This work is almost finished. Results will be communicated.

The most important difference with all the existing standards or guidelines for EPS blocks is that density is not a requirement anymore but only an aid for internal QA. That means that industry can develop product types especially meant for specific applications or even a building site. This enables product innovation and expanding possibilities for EPS applications.

The requirements in the newly developed standard are set in terms of levels or classes for general applications (mandatory) and specific applications. These properties will be explained; a special chapter on evaluation of conformity completes the standard.

---

[1] Hans Tepper, M. Sc. Civ. Eng., is managing director of STYBENEX, the Dutch association of EPS building products producers

INTRODUCTION

An increasing application of EPS in civil engineering demands for a product standard for blocks and thick boards. The existing standard for building insulation is providing the necessary basics. However typical differences with the existing standards in de European Union and the building insulation standard make the draft "block" standard a separate one, to be judged on itself [1].

In comparison with all existing standards in the EU, the main difference is that density (formally given in terms as EPS 15 of EPS 20) is not a requirement as such any more but an aid for internal QA because other properties -required for the end use application- can be achieved regardless of density thus improving innovation for producers.

After thorough discussion in the Nordic part of Europe an extra dynamic stability test was added to provide for railroad application.

EU PRODUCT STANDARDS

The objective of the Construction Products Directive (CPD), issued in 1990 [2], was free trade of construction products between the member countries of the European Union. The EU mandated CEN (Commission Européen de Normalisation) to create product standards and test methods for this purpose. For insulating materials CEN TC 88 was established, for calculation rules CEN TC 89.

In CEN TC 127 "Road Materials" it was discovered at the same time that "Geofoam" standards were not incorporated in the scope of their TC and thus TC 88 was asked to provide these standards from their 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. With this it 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/ 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 XPS industry also started a similar project. Both were mandated by the EU to CEN.

CE MARKING AND LABELLING

Products that fulfil the requirements of the harmonised product standard are allowed to be CE marked thus showing the conformity. This CE- marking acts as a "passport" for free trade over other EU- borders. However the application has to fulfil the "local" building requirements as compressibility, structural stability, creep, etc.

As the European Union wants to set clear how conformity to the intended use has to be dealt with, a specific annex ("ZA") is provided by the EU to deal with this. In Figure 1 a frame for CE marking is given.

COMPOSITION OF THE STANDARD

The "EPS in CEA"- product standard contains -next to introduction paragraphs- a list of properties to be declared by the manufactures on the basis of validated test methods.

For tolerances "zero"- classes were introduced to be able to deliver blocks for lightweight fill that will never be in a "loaded" application e.g. were 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 application. This enables QA to be set up with less different specifications.

From the requirements for all applications the declaration of compressive stress at 2% **or** 5% **and** 10% is the most important issue. Determination has to be following EN 826. Depending on the type of application and the performance requirements this will be set.

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 requirement at 10% deformation is anyhow meant for designation purposes and not an application related requirement. It fulfils anyhow the gap for producers between building insulation QA and that of QA for blocks for CEA.

The EN standard EN 826 allows anyhow for the determination of compressive stress in fact al any deformation. Calculation rules for the E modules over the elastic part of the stress/ strain curve are also given.

The ration between the declared levels for 2% **or** 5% **and** 10% is about 0.60, 0.90 and 1.00 being the normal relationship for a specific EPS product type.

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

For specific applications the consultant is free to set requirements depending on the application; if not required the producer needs not to determine and not to declare!

This is valid for:

- dimensional stability at specific conditions
- bending strength
- compressive creep
- thermal conditions
- water absorption
- freeze- thaw resistance
- resistance to cyclic loading

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 determined by direct testing. It is anyhow possible to use density as a means to decrease costs of internal QA when the "standard" curves -based on European data gathered over 25 years- are used. This enables also to predict compressive stress at 10% and thermal conductivity in relation to density for consultants! The relationship between density and compressive stress is given in Figure 2; in Figure 3 the same is done for thermal conductivity versus density.

EPS PRODUCT TYPES

EPS-Products are divided into types as shown in Figure 4. Each type shall satisfy two different conditions at the same time in order to ensure adequate product performance. Only if the classification requirements given in this table are fulfilled, the additional properties given in an Annex to the draft standard apply , here given in Figure 5.

ADDITIONAL PROPERTIES

In a informative annex to the standard a correlation between bending strength and shear strength is given. Next to that information about 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 σ_{10}.[3].
Compressive creep in reality will be less then predicted by testing small samples due to stiffening of the matrix and the volume effect of blocks used. With this designers are able to connect other relevant product properties to a chosen product type.

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 SP 2687 [4]. In the latter case no test result shall exceed 5% permanent deformation after $2x10^6$ load cycles with load levels of 100, 200 or 300 kPa respectively.

REFERENCES

[1] CEN TC 88/WG4/N05-01E, “Draft EPS in CEA standard, version 2.1”

[2] Construction Products Directive (CPD), EC 89/106, Brussels 1990

[3] Struik, L. C. E., Physical aging in amorphous polymers and other materials, Elsevier Sc. Publ. Cy, 1978.

[4] SP 2687, "Determination of the resistance to cyclic compressive loading ", Boras (SE), 2001

Tables, figures and graphs

CE Number of notified body (for products under system 1)
Name or identifying mark and registered address of the manufacturer or his authorised representative established in the EEA. Two last digits of year of affixing CE marking. Number of EC certificate of conformity (where appropriate).
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).

Figure 1: Framework for CE marking

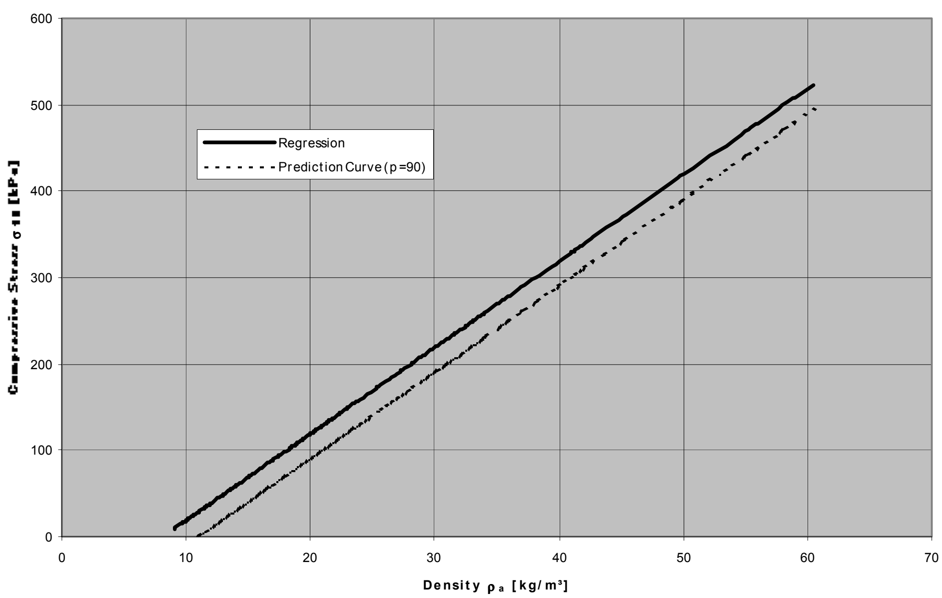

Figure 2:Compressive stress at 10 % deformation

Relationship between compressive stress at 10 % deformation and apparent density for indirect testing; *p* = 0,90; *n* = 495.

Regression for $\rho_a \geq 9$ kg/m³:

$\sigma_{10,\text{ mean}} = 10{,}0$ m²/s² $\times \rho_a - 81{,}0$ kPa [kPa]

$\sigma_{10,\text{ pred}} \approx 10{,}0$ m²/s² $\times \rho_a - 109{,}1$ kPa [kPa]

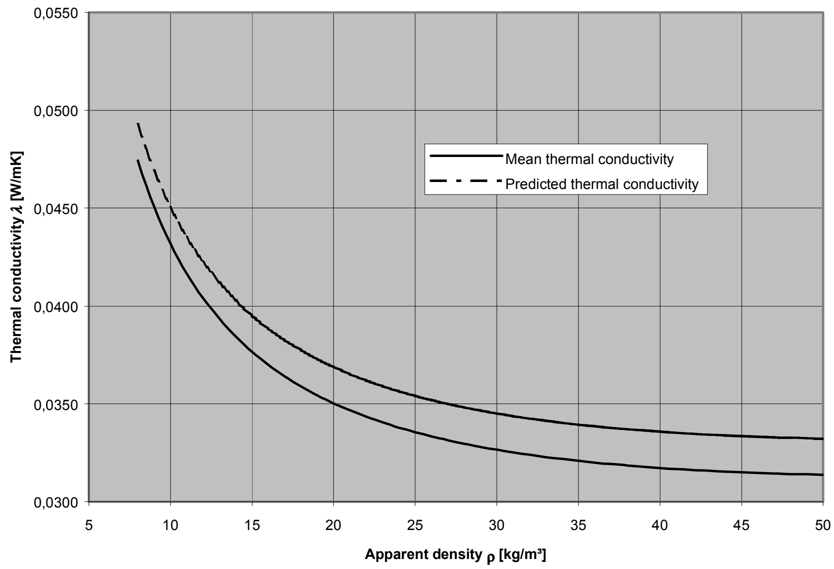

Figure 3: Relationship between declared thermal conductivity (at 50 mm reference thickness) and apparent density; *p* = 0,90; *n* = 3873.
Regression for 8 kg/m³ ≤ ρ_a ≤ 55 kg/m³:
λ_{mean} = 0,025314 W/(mK) + 5,1743 · 10^{-5} Wm²/(kgK) × ρ_a + 0,173606 Wkg/(m^4K) / ρ_a [W/(m·K)]
λ_{pred} = 0,027167 W/(mK) + 5,1743 · 10^{-5} Wm²/(kgK) × ρ_a + 0,173606 Wkg/(m^4K) / ρ_a [W/(m·K)]

Type	Compressive stress at 10 % deformation kPa	Bending strength kPa
EPS 40	40	60
EPS 50	50	75
EPS 60	60	100
EPS70	70	115
EPS 80	80	125
EPS 90	90	135
EPS 100	100	150
EPS120	120	170
EPS 150	150	200
EPS 200	200	250
EPS 250	250	350
EPS 300	300	450
EPS350	350	525
EPS 400	400	600
EPS 500	500	750

Figure 4: Classification of EPS products

Bending strength σ_B requirement kPa	Shear strength τ correlation kPa
50	25
75	35
100	50
115	55
125	60
135	65
150	75
170	85
200	100
250	125
350	170
450	225
525	260
600	300
750	375

Figure 5: Additional properties of EPS

Acknowledgement

Two years of hard labour and discussion needs me to thank the Task Force members for their valuable contribution- in random order-: R.Fagervoll (Sunde, NO); R. Aaboe (NRRL, NO); I. Brorsson (SGI, SE); S.Hoikkala (FINFIP, FIN); O.Anttila (FRA, FIN);F.Hohwiller (BASF, DE); E.Thelberg (Sundolitt, SE) and six corresponding members under the convenorship of the undersigned.