

EU PRODUCT STANDARD FOR EPS AND PERFORMANCE REQUIREMENTS

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ABSTRACT

As a result of the EU policy to strengthen the European Union by encouraging free trade of building products between member countries, product standards for almost hundred building product groups were created over the past 20 years. The product standard for EPS in Civil Engineering Applications (EN 14933) came into force in March 2009. This presentation will focus first on the results of the implementation of the product standard EN 14933 in the EU, the consequences for designers, engineers, authorities and contractors when applying EPS in civil engineering under the title: "expanding possibilities?". Nevertheless in between it came clear that per country different performance requirements still existed and that the relation between performance requirements and product properties also differs. This has to be solved and the second part of the presentation will focus on the outcome of an inventory by a special Task Force of EUMEPS, including the use of Eurocodes which are mandatory since last year.

EU STANDARDISATION PROGRAM

Construction Products Directive

The Construction Products Directive (CPD, EU98/106) came into force in 1990; and the European standardizations institute "Conseil Européenne de Normalisation" (CEN) was mandated by the EU to establish a number of harmonized product standards. CEN Technical Committee TC 88 was commissioned not only to create standards for insulation materials but also for rigid foams in civil engineering applications (CEA) as Expanded Polystyrene (EPS), Extruded Polystyrene Foam (XPS) and Expanded Clay beads; this in close corporation with CEN TC 227 "Road Materials". In 2001 the draft standard for EPS was completed, nevertheless it took years to issue the final document as a result of harmonization with the XPS draft standard and editorial changes of Annexes by the EU and CEN. EN 14933 [1] was approved by CEN at 13 July 2007 and the three standards came into force as a package in March 2009 and is a mandatory standard for all EU member states since the 1st of January 2010.

Harmonized European standards (hEN's)

These harmonized European standards have the same format: a number of product properties are mentioned (divided in those for all applications and those for specific applications), the accompanying determination method (a testing procedure), rules for marking and labeling and obligations on the level of third party quality assurance. Products as placed on the market have to

be marked and labeled with the CE mark and a manufacturer's declaration on the products properties. Not doing this is from the date of implementation an economic crime.

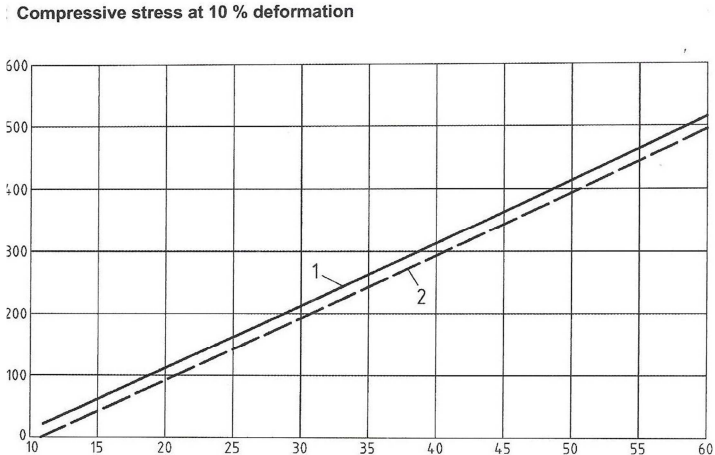
The standard for expanded polystyrene, EN 14933, is based on the EPS insulation standard EN 13163 for buildings, but with a specific subdivision and extensions that enables producers to define EPS product types that fulfill requirements of both standards, possibly even combined with products of EPS for industrial installations and building equipment according to EN 14309.

CONTENT AND CONSEQUENCIES

To give background information on the influence of the European standard in practice the following aspects need to be highlighted.

Product types based on compressive strength

In the past product types were based on density and research on EPS properties and performance in application followed this. The competition between producers and the decreasing market anyhow caused poorer product quality and from this point of view the new standard is a success. Next to that producers with a "High-Tec" internal quality system are now able to produce with less density (raw material) the same declared compressive strength. Densities in the past of 20 kg/m³ gave a compressive strength at 10% deformation of just more than 100 kPa; nowadays a declared value of 100 kPa can be reached with a mean density of 16.8 kg/m³. For reference a relationship for indirect testing is given in EN 14933, Figure B.1

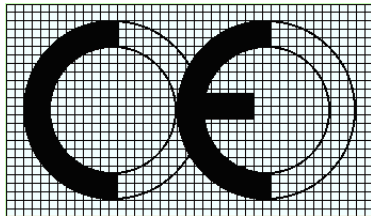


Determination of behavior under cyclic square-wave load

The behavior of EPS under dynamic loads was already defined in EN 13793 with a sinus load, but for railroad applications Swedish experts from industry and authorities desired harmonization with their existing standard SP 2687 with square wave load; thus this was incorporated as normative annex D.

CE marking and labeling

Since 2009 CE marking and labeling is thus mandatory for EPS brought on the market for the applications, given in EN 14933. It acts as a "passport" for EPS to be brought on the market throughout Europe. Although in the beginning producers were reluctant in doing so, nowadays this is no problem anymore and free trade is getting normal. What is not regulated uniformly in the EU is the "visa" for the application - the connection between performance requirements and product properties - as shown hereunder.



Voluntary quality systems

Next to the mandatory CE marking in most EU member states voluntary quality systems occur; in practice producers are joining these systems for commercial reasons. Some systems only add a third party quality assurance system as part of the system (KOMO in the Netherlands and ACERMI in France), others also add specific requirements to the properties, as the minimum density per EPS product type (the situation in Germany). Although the EU's "Standing Committee for Construction" does not encourage this, it is acceptable when it is separated from the mandatory CE marking system. Voluntary quality assurance improves product quality and decreases the variation in compressive strength.

Sustainability

One of the "essential requirements" (ER3) in the CPD concerns the environmental aspects of products in building and construction. To this "Environmental Product Declarations" (EPD's) have been set up for most major products. On the basis of Products Category Rules, which are widely accepted for insulating materials, this EPD has been set up for EPS last year [2].

It enables environmentalists to calculate the total environmental impact of specific works and gives the opportunity to compare different solutions on the environmental aspects. Studies on specific applications in the Netherlands show that EPS is environmentally at least equal or better to other solutions with sand, pre-settlement loadings and piled foundations [3].

Regardless of this requirement "Integrated Chain Management" is also one of the major issues to promote EPS as an environmental sound solution and for some authorities this is even an aspect for the choice of the technical solution. In some countries this caused the set up of a system of recycling of used EP and concerns EPS packaging, thermal insulation and light weight fill. See for an example the organization GEOBLOCK® in the Netherlands, www.geoblock.nl The use of recycled material increases the variation of the compressive strength and should be taken into account in statistical calculations.

Construction Products Regulation (CPR)

Soon the successor of the CPD - the CPR - will come into force; this implies that product standards also should give guidance to the user how to use the product in its application, e.g. how to calculate with the compressive strength in civil engineering constructions. It will be the task of CEN TC 88 to realize this after a mandate from the EU. A Regulation means "law" thus cannot be avoided or changed to comfort local situations, i.e. mandatory.

Sample size

In the current EN standard of 2009 sample sizes of 50*50*50 mm³ are prescribed; experience shows that larger samples give results that are better comparable to the application with bigger blocks. This has to be sorted out in the near future.

Creep factors

The ratio between long term loading and short time strength is often held at 0,3 to avoid excessive creep; research in Sweden and Finland shows on the contrary that factors from 0,4 to 0,45 can be applied for specific developed EPS qualities. This implies lower densities for the EPS to be applied and thus a better competitive situation for light weight fill!

EXPANDING POSSIBILITIES???

Free trade

The new EN 14933 has undoubtedly contributed to the free trade of EPS in civil engineering; deliveries over the borders of Germany, Belgium and the U.K. are well known.

Producers possibilities

With the above issues highlighted it is clear that for producers a new era has come: the standard together with quality assurance is easily translated into a more reliable product quality, a lower consumption of raw material and thus gives more financial profit.

Clear definitions

Most producers appreciate the clearer situation on product performance: with products confirming the regulations commercial competition concerns now aspects as logistics, capacity, service, sustainable versions and still last but not least: price.

Conclusion

At the time that the draft standard of EN 14933 was explained to a wider public [4] the author was convinced that the standard would give:

- Freedom of trade over the borders
- Freedom of design for the engineer
- Freedom of product types for the producer

and that has been reached but there is more to do...

PRODUCT PROPERTIES FOR CALCULATION

CEN standards

Those only involved with CEN standards are convinced that the EPS product types, based on compressive strength at 10% deformation, have a characteristic value that is shown by this value. For design purposes this has been worked out and was presented by the author at the Global Insulation Conference in Prague (CZ) fall 2009 [5]. This shows the following data:

Table 1: Design properties of EPS

Property			EPS product type				
Description	Symbol	Unit	EPS60	EPS100	EPS150	EPS200	EPS250
Declared value short-term compressive strength	σ_{10}	kPa	60	100	150	200	250
Design value short-term compressive strength	$\sigma_{10;d}$	kPa	48	80	120	160	200
Modulus of elasticity	$E_t; E_{dyn}$	kPa	4000	6000	8000	10000	12000
Declared value permanent compressive strength	$\sigma_{10;perm}$	kPa	18	30	45	60	75
Design value permanent compressive strength	$\sigma_{10;perm;d}$	kPa	14,4	24	36	48	60
Declared value compressive strength under cyclic load	$\sigma_{10;cycl}$	kPa	21	35	52,5	70	87,5
Design value compressive strength under cyclic load	$\sigma_{10;cycl;d}$	kPa	17	28	42	56	70

Eurocodes

The determination of product properties useable for calculation purposes in Eurocodes EN 1991 and EN 1997 differs from the above approach. It is based on a scientific approach which is normally used for "known" materials as steel, concrete, timber etc. In Sweden this has already been worked out thoroughly by WSP [6] in corporation with the EPS industry for load bearing constructions as in housing, slab-on-ground floorings etc. In the end probably the design and the

applied EPS type will not differ so much, but given the circumstances as shown above this needs a scientific and technical feasible approach as all insulation standards should adopt this approach in the future too!

The way forward

EUMEPS, the European EPS association has set up a Task Force to deal with this, taking into account:

- Existing CEN standards, the Eurocodes and statistics
- Prediction of variation in products as to recycling, certified processing, QA etc.
- Sample size influence
- Creep factors for special products
- CPR instead of the CPD
- Existing guidelines in the EU

CALCULATION RULES

Guidelines and regulations

Several guidelines exist in the EU next to Building Regulations - the latter in most cases do not cover these civil engineering applications - such as the Sétra Guide (FR), The BAST requirements (DE), the CROW 150 guideline (NL), WSP guidelines (SWE) and a publication in "Construction and Building Materials" (UK). An USA guideline (NCHRP doc 65) is throughout the world often used as reference document. All the EU-guidelines need to be updated with regard to Eurocodes, the EN 14933 and a decade of experience with these guidelines.

Eurocodes and national application annexes

The Eurocodes EN 1991 and EN 1997 give a direction how to proceed; for (simplified) calculations an abstract could help all experts involved in design to understand the possibilities better. One specific issue has been raised: the translation of traffic loads (wheel loads) into uniformly distributed loads when no concrete slab is applied on top of the EPS layer. A nice task for that Task Force of EUMEPS together with the experts!

CONCLUSIONS

- The EPS product standard EN 14933 has brought transparency for designers, producers and authorities and opened the market for free trade of building products in the EU.
- The mandatory CE marking has brought controlled quality and reduces raw material consumption within a product type.
- For calculations the characteristic values of EPS properties have to be redefined according to Eurocodes and have to be incorporated in product standards, to comfort the new CPR too.
- Several issues have to be resolved in this process: variation of properties, influence of certification, sample size, use of recycled EPS, creep factors tec.
- The connection between product properties and performance requirements have to be issued in a simplified format, to easy experts to choose for light weight fill - and EPS in particular - by taking away "cold water fever".

References

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11-04-2011/Apr