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NEW DEVELOPMENTS IN THE FIELD OF CONCRETE PAVING BLOCKS IN BELGIUM

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1. INTRODUCTION

The interest in concrete paving blocks, available in various forms and colours, has increased considerably over the past few years.

In Belgium, production rose from about 1 million m^2 in 1980 to more than 8 million m^2 in 1993. Concrete paving blocks are mainly chosen because they offer both aesthetic and functional advantages besides the well-known technical properties of concrete.

The new developments in the field of concrete paving blocks partly concern the blocks themselves - a new NBN B21-311 standard "Concrete paving blocks" was issued in 1992 - and partly the new trends in the use of concrete paving blocks - i.e. for refitting regional roads, streets and squares.

Furthermore, it should be pointed out that the general clauses of tender specifications for concrete paving blocks have been widely extended.

2. THE NEW NBN B21-311 STANDARD "CONCRETE PAVING BLOCKS"

To meet the ever-increasing demand for concrete paving products, many producers have adapted and extended their range of products in recent years.

With these new developments and the frequent application of the "lay-down" method which consists of laying the blocks closely together on a screeded sand, a revision of the old Belgian NBN B21-311 (1974) appeared to be necessary while considering the standardization work of the CEN at the European level. The main changes are summarized under the following points:

2.1. Smaller tolerances in dimensions

± 2 mm in length and width
± 3 mm for the thickness (even for a thickness of 120 or 130 mm).

Small tolerances in length and width are obviously necessary for the lay-down method, especially for the good realization of different laying-patterns.

Small tolerances in thickness appear needful to obtain and to guarantee a flat surface. Also for special constructions such as speed ramps and raised junction where often laying courses of sand cement are used, too great differences in thickness between adjacent blocks cannot be permitted.

2.2. Chamfers

Arrises described as square may have a bevel with horizontal or vertical dimensions not exceeding 2 mm. Such paving blocks are often used for cycle tracks.

A bevelled arris exceeding 2 mm shall have a bevel of minimum 3 mm and maximum 7 mm.

2.3. Facing layer

In the new Standard NBN B21-311 a facing layer with thickness not less than 4 mm (over all the layer) is introduced. Such a layer is more and more used, especially for coloured concrete blocks, which are very popular in Belgium, and their application is still growing.

Since a few years, several manufacturers are using not only pigments but even naturally coloured aggregates in the facing layer to obtain colourfast paving blocks.

Some people fear that problems could come up with the bond between facing layer and the rest, especially in frost conditions. In fact this facing layer technique is applied since a long time to produce white coloured concrete blocks, mostly destined for marking signs in roads pavements (e.g. on pedestrian crossings). In these cases the thickness of the facing layer is generally 8 to 10 mm. Problems of bond with these white blocks are really unknown.

In actual practice the thickness of the facing layer is not always perfectly uniform but varies normally several mm. Hence, they fluctuate generally between 6 and 10 mm, as well for coloured as for uncoloured concrete paving blocks. If naturally coloured concrete aggregates are used, the average thickness of the facing layer is mostly more than 8 mm.

We can actually state that not too young concrete blocks with chamfers, and placed with small joints (average 2 mm) don't run the risk of damage such as surface splitting off. Also the application of space nibs or special chased side faces can help to avoid damage because it reduce contact pressure on the top of the blocks.

The use of chased side faces seems to give the best results. Nibs can indeed lead to high splitting pressure, followed by cracks. Furthermore rather thick nibs (3 - 5 mm) conduct to wide joints which need carefully joint filling, otherwise the blocks will move on the bedding sand and even dislocate. Thick nibs can also create some problems for the realization of certain laying patterns.

2.4. Replacement of compressive strength by splitting tensile strength

The revised NBN B21-311 (October 1992) incorporates the following requirements for the splitting strength in accordance with the NBN B15-218 (1986):

- individually: min. 3,5 MPa
- average: min. 4,5 MPa

Results to achieve on blocks which have been submerged in water for 4 to 5 hours and as a rule min. 28 and max. 35 days old. During the normal control for the BENOR-mark earlier tests are regular, e.g. at 14 days. Also at such young age the mentioned requirements are normally obtained.

Taking into consideration an average relation between compressive and splitting strength of 13,2 approx. (for blocks with a thickness $\leq$ 100 mm) the actual requirements should correspond to a minimum compressive strength of 50 to 55 MPa and an average compressive strength of 55 to 60 MPa (wet method). As a actual practice, the average splitting strength is generally higher than 5 MPa (after 28 days) with a common standard deviation of 0,30 to 0,50 the correspondence compressive strength range 60 to 70 MPa. This means an improvement in quality of the old norm which required an average of min. 60 MPa after storage in a drying oven.
As the thickness has an effect on the splitting strength a correction factor c is adopted (tabel 1).

Tabel 1 - Correction factor for splitting strength

Thickness (mm)	Correction factor c NBN B21-311 (October 1992)	Correction factor k (pr EN 1338 October 1993)
60	0,90	0,87
70	0,95	0,94
80	1,00	1,00
100	1,10	1,11
120	1,20	1,19
130	1,25	1,23

2.5. Waterabsorption and resistance against frost and de-icing salts

The old norm already outlined the requirements concerning water absorption for concret blocks (NBN B15 - 215). A limited waterabsorption combined with a high compressive strength (guarantee for enough cement) makes generally concrete resistant against frost and de-icing products.

Nevertheless in some cases e.g. when the required strength is only just achieved, the limited water absorption (individually max. 5,5 % and average 5 %) seems not always a guarantee for a good resistance against de-icing products.

Therefore requirements should be accepted in new standards. Especially decorative coloured paving blocks for which in some cases (e.g: $t < 80$ mm) the waterabsorption may reach individually 6,5 % instead of 5,5 % need, if used on public roads requirements concerning resistance against de-icing salts such as $CaCl_2$ and NaCl, mostly used in Belgium.

Indeed, coloured paving products should meet stricter demands regarding de-icing products, in order to better safeguard the surface quality and its related colour-fastness.

In actual practice it seems that concrete paving blocks with facing layers which contain more than 380 kg cement per m^3 resist very good to de-icing products.

Test according the ISO IS 4846.2 pre norm on such min. 28 days old products showed that the loss of mass after 30 frost-thaw cycles is mostly less than 5 g/dm^2, and in some cases even beneath 1 g/dm^2.

2.6. Abrasion

For thin paving blocks ($t < 80$ mm) - often decorative elements - some allowances are made in the revised Belgian norm regarding the abrasion as mentioned in table 2. (Test in accordance with the NBN B15-225/1990).

Tabel 2 - Maximum abrasion

Thickness (mm)	Individually (mm)	Average (mm)
$t \geq 80$	2,5	2,0
$t < 80$	3,0	2,5

The highest values are identical with the requirements for flags.

3. CONCRETE PAVING BLOCKS FOR REFITTING ROADS, STREETS AND SQUARES

Because of the large number of traffic accidents on Belgian roads, especially in built-up areas, special efforts have been made for several years to improve the situation.

The following initiatives and legal measures were taken:

- in 1978: residential yards ("woonerven"),
- in 1983: speed control humps,
- in 1988: 30 km/h areas.

Further to these measures, many small-sized concrete products - mainly concrete paving blocks - are used.

In order to improve traffic livability and safety on local roads, decorative paving blocks are now increasingly applied in addition to traditional concrete paving blocks. Square blocks with shades and lights are receiving an ever-growing interest. With the revision of the NBN B21-311 standard, high-quality products with the BENOR approval mark can now be produced in this range too, as explained under point 2.

Furthermore, it should be noted that since a few years many raised junctions have been constructed, even with shifted centre lines.

These pavements are mostly realized with a base of cement stabilized materials (0/20 or 0/30) and a laying bed of sand-cement for the paving blocks, which are normally laid in herringbone patterns to resist slewing or turning loads. To avoid pulverizing of the bedding sand-cement, due to shocks of heavy loads on raised junctions coarse angular materials (0/4 or even 0/7) with an high crushing resistance seem to be necessary.

As the slope of raised constructions and road crossings is not always sufficient for a good water drainage, permeable bedding sand and bases are advisable to permit drainage of water that penetrate through the joints. Waterstagnation between bedding sand and paving blocks should absolutely be avoided, certainly in a rainy region like Belgium, otherwise dislocating of the paving block can be expected.

To limit traffic accidents on Belgian roads, not only raised junctions but also roundabouts are more and more constructed since a few years.

Concrete paving blocks are often used for this purpose, sometimes in combination with monolithic road surfacings. By contrasting forms and colours it is possible to accentuate the various functions.

4. NEW APPLICATIONS AND TECHNIQUES

- Concrete paving blocks are also frequently applied in industrial and port areas. To increase their resistance to shocks a few experiments have been carried out with steel fibre-reinforced concrete blocks.

- Concrete paving blocks were even used to overlay an old cobble stone pavement with a high longitudinal slope. A special paving bed of dry cement mortar was necessary to fix the concrete blocks.

5. CONCLUSIONS

- With the revision of the Belgian NBN B21-311 standard high-quality decorative concrete paving blocks can now be produced and accepted, which is especially interesting for renovation works.

- The ever-growing concern for the environment and for safety makes concrete paving blocks particularly attractive and will surely lead to higher sales in the future.