HOLCOFIRE FINAL RECOMMENDATION

IPHA, in cooperation with BIBM, executed The European project “HOLCOFIRE” with the objective to get full understanding of the behaviour of prestressed concrete hollow-core slab floors under fire conditions. The Holcofire project consisted of meta-analysis, laboratory fire tests, finite element simulations, and calculations conducted by experts in the field of precast hollow-core floor construction and fire testing. A final report was published 24 January 2014. More background information is given further below.

After the HOLCOFIRE report was finished, additional work was carried out in The Netherlands for a local Dutch Approval. A Dutch Approval - by the minister recognized quality certificate – published 25 November 2015 declares that floors assembled from - CE marked - hollow core slabs meets the requirements as stated in the Dutch Building Law. It contains a recommendation on the thickness of the topping with regard to the structural fire resistance of hollow-core slab floors applied in new buildings.

It is recommended that for the structural fire resistance of floors composed of hollow-core slabs (on which an adhesive finishing screed or structural topping with a thickness of more than 50 mm is applied in buildings ranked in consequence class 2b of 3), the following limit for the thickness of the topping applies:

- 0.25 x depth of the hollow core slab, with a maximum of 100 mm

In case of a larger thickness of the topping then mentioned above in buildings ranked in consequence class 2b of 3, measure A from BFBN recommendations are needed, to be assessed by the main structural engineer. Find as a pdf-download the Dutch recommendation “Design recommendations for the structural safety of hollow-core slab floors in the event of fire in new buildings (25-11-2018)”

BACKGROUND HOLCOFIRE

The Holcofire end report was published in a book that is available online or through IPHA (ISBN 978-90-8891-812-4, Structural behaviour of prestressed concrete hollow core floors exposed to fire, Jansze, W., van Acker, A. et al., 226 pages, published 24 January 2014). The Holcofire's end report concludes that further research-testing on hollow-core slabs with regard to fire resistance is not necessary. All available regulations and requirements for hollow-core slab floors under ambient conditions and under fire conditions have been derived and verified on the basis of real experiments.

The end report covers various subjects:

- A database covering the years 1966-2010 was set up with 162 fire test results in order to perform a meta-analysis over the fire tests. It is concluded in that 94.5% of the database can be fully explained with the design models and requirements stated in the available European standards (EN1992-1-2, EN1168, EN1363-1, EN1365-2). The other 5.5% is dealt with in the Holcofire study as a specific research subject.
- In performed Holcofire tests (the G series) the shear formula presented in EN 1168/A3 Annex G was compared with 42 fire test results from the database and the Holcofire fire tests G1 to G7. It is concluded that with this EN1168 Annex G formula for shear and anchorage resistance under fire, the designed hollow-core floor is safe for the ultimate limit state in the accidental situation. In a subsequent desk-study it is concluded that the EN1168 Annex G formula can also be used to determine the shear and anchorage resistance under fire for hollow-core floors on flexible supports.

- The Rotterdam fire case has been analysed in a retrospective view, with in-depth analyses leading to new insights. In a finite element simulation of the real fire of Rotterdam with FDS5 software led to the conclusion that the fire was far more severe than an ISO fire due to the travelling characteristics of the fire, leading to a 33% rise in temperature above car 1 in 20 minutes and a threefold temperature increase rate. A clear explanation of the successive phases of delamination of the bottom flange is given.
- In performed Holcofire tests (the R series) the capacity of hollow-core slabs under restrained conditions was investigated. The overall conclusion reached is that high floor restraints due to horizontal blocking and thick topping can lead to buckling spalling and horizontal web cracking. However these are concluded not to be failure mechanisms. Under the design load and well anchored strands, the fire resistance was still met through the structural redundancy and alternative load paths in the hollow-core slab floor.
- The Holcofire Frame Model clearly shows that the initiation of horizontal web cracks and buckling spalling at the soffit can clearly be simulated with a limited number of parameters. It is concluded that it is not the thickness of the structural topping, but the magnitude of transversal restraint that has the most influence on both phenomena. Shrinkage cracks and dilatations in hollow-core floors used in practice are enough to keep these transversal blocking effects at such a low level that horizontal web cracking and buckling spalling of the bottom flange are unlikely. This explains why these local damages are only seldom observed in practice. And when observed, they are incidents, like the Rotterdam fire case where the fire was far more severe than an ISO fire.
- Real fires in car parks are accidental, severe and unpredictable and due to blocking effects will always cause local damage to any flooring structure; hollow-core floors, but also other precast floors, cast in-situ floors and composite solutions.

The Holcofire study concludes that the proven track record of more than 1,000 million m^2 of hollow-core floors in Europe plus the extensive testing of hollow-core slabs in laboratories and the analysis of the real fire in the Rotterdam incident confirm once again that hollow-core floor systems meet all regulatory, quality and safety requirements. The Holcofire lessons learned are, firstly, that the product meets regulations and requirements; secondly, that the product performs well when exposed to fire; and thirdly, that in specific cases real fires in car parks are far more severe than standard fires. Based on the knowledge and experiences gained in this European project carried out by experts and reported on in this book, there is no need anymore for further fire testing and modelling. Society can continue to rely fully on the structural solid performance of floors consisting of hollow-core slabs.

If approval fire tests are necessary, it is recommended or even mandatory to follow the existing European standards for fire testing on floors (EN1363-1, EN1365-2). These standards apply to any floor structure and thus also for hollow-core slabs.

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