METHODS OF MEASUREMENT AND CONTROL OF LEVELNESS AND FLATNESS OF INDUSTRIAL CONCRETE FLOORS

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Abstract: The operational suitability of industrial concrete floors is an integral characteristic associated mainly with the ability to safely absorb the intended loads and technological comfort during operation.

In this sense, the requirements to the finish surface in a level, most often expressed with two basic parameters, etc. "flatness" and "levelness" are essential. The two parameters are independent of each other - the flooring can be flat, but not level, as well as level but not flat. The significance of the two parameters increases with the height of the racking systems and is in direct connection with the transport system of the lifting equipment.

The report discusses the existing methods for measuring and controlling the levelness and the flatness in specific conditions of lack of normative documents in Bulgaria and worldwide.

Key words: concrete industrial floorings, levelness, flatness

1. Introduction

Typically, the operating conditions in the major logistics centers provide for a mixed cycle of transport-lifting equipment - loading and unloading in free moving areas (FM) and specialized storage of certain pallet trucks in high-racking systems, where transport-lifting equipment is mainly driven in limited-defined-movement areas (DM) - Fig.1 and 2.

In this sense, the requirements to the finish surface in a level, most often expressed with two basic parameters, etc. “flatness” and “levelness” are essential. The two parameters are independent of each other - the flooring can be flat, but not level, as well as level but not flat - Fig. 3.

The theoretical level ± 0.00 on the finishing surface (so called datum of the pavement) can’t in all cases be strictly observed throughout the whole area, given the technological characteristics of the floorings. Then the question of criteria of tolerances of this value arises.
2. Levelness and flatness measuring

In the report below the discussed features of the measurement technology and the specification of the tolerances under different conditions are according to the accepted criteria, included in TR34 Industrial Ground Concrete Floors - 4th Edition (2013), Concrete Society, U.K. [1]. The report is accepted as official document (not standard one) in most of the English speaking countries.

In this case, it is necessary to highlight the difference in the approach of this and the previous document TR34-3rd Edition (2003) [2]. The new version is fully developed in accordance with the principles set out in the relevant European Standard EN 15620:2008 Steel Static Storage Systems. Adjustable Pallet Racking. Tolerances, Deformations and Clearances [3].

It is assumed that the actual level of newly built flooring is within ± 15 mm of the fixed floor datum. If for any reason an elevation of ± 0.00 is not set, all points should be within ± 15 mm of the overall floor area average level. The tougher requirements are directly related to the type of pavement, in particular to its specific areas, and the nature of the truck's movements in free (FM) or defined moving zones (DM).

For free movement zones (FM), two distinct types of levelness and flatness indicators are specified - E and F. Property E represents the deviation from the levelness of the flooring, measured on a pre-developed square mesh (square side of 3 m) over the whole surface (not on the diagonals of the net and as long as the development of the net is at least 1.5 m from walls, columns and other built-in or peripheral vertical elements (Fig. 4), while the flatness (F-properties) is based on measurements over every 300 mm in all directions (Fig. 5).

Both levelness and flatness are specified by carrying out within the pre-developed network - for property E are made at the intersections of the square mesh (the use of an optical level device). For those for the F-property - at ten intermediate points in the mutually perpendicular sides of the 3-meter network (a digital profile-meter type is required).

For restricted defined movement areas (DM), especially narrow passageways in the interplanar spaces, the flatness of the pavement is a limiting factor, especially in the case of a technologically necessary high lift height - Fig. 6. In this case it should be noted that attention should be focused
precisely on these transport corridors, whereas the area covered by the projection of the racking system on the pavement is not essential given the practical lack of any transport in these areas.

Classification of industrial concrete floor coverings in terms of their flatness in restricted mobility areas (DM) is shown in Table 2. The definition of the characteristic indicators is presented below and illustrated in Fig. 7, 8, 9 and 10:

- **Property Z** – The transverse dimension between the centre of the truck front wheels, m;
- **Property X** – The longitudinal dimension between the centre of the truck front and rear truck wheels, fixed to 2 m;
- **Property Zslope** – The cross-aisle slope between the centres of the truck front wheels, mm/m;
- **Property dZ** – The elevational difference between the centre of the truck front wheels, mm;
- **Property dX** – The elevational difference between the centre of the front axle and the centre of the rear axle, mm
- **Property d2Z** – dZ changing in front movement of 300 mm;
- **Property d2X – dX** changing in front movement of 300 mm

The necessary measurements shall be made with a specialized device - a digitized profiler, and the results of the subsequent calculations shall be evaluated on the basis of their compliance with the limits in Table 2. Conclusions of unsuitability of the pavement in terms of flatness achieved are only made if all measurements of all axles exceed all limit values. The latter means the partial admissibility of inaccuracies, excluding the possibility of the flooring being accepted only if these inconsistencies apply to all properties.

Otherwise, specific measures will be taken to
address the flatness problems - especially laser surface grinding (the most modern but expensive technology to correct the entire space or only wheel area based on the cost of expensive equipment), or, eventually a high-precision conventional machining local grinding of the "high" zones.

In summary of the above, it should be noted that the accuracy of the measurements made must be at 0.1 mm, and the accuracy of the individual records should be of the same range. The final measurements should be carried out within the next 1 month after completion of the pavement, given the resulting volumetric changes of the concrete section caused by possible base settlements, deformations from the external load, potential curling effect, and so on.

All participants in the investment process should make it clear that concrete, in particular industrial concrete floorings, are dynamically changing time system, influenced by a number of factors, which inevitably leads to a change in the finishing surface in a level [4].

3. Conclusions

The implementation of industrial concrete flooring is of increasing importance for today's construction. Unfortunately, the necessary regulatory framework is lacking throughout the investment process (technical assignment, designing, quality criteria, etc.) it lacks the necessary legal basis. This also applies to the adoption of a uniform methodology for defining criteria for levelness and flatness as key properties for normal pavement operations.

In this respect, the development of regional regulatory framework within the EU is becoming an immediate task. This could be realized easily through a uniform perception of the provisions of above discussed TR 34-4.

References


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