



Figure 1: Steel fabric placing.

Quality control for warehouse and industrial floors

Anecdotal evidence suggests that the quality of warehouse and industrial floors has improved in recent years since the publication of the Third Edition of Technical Report 34⁽¹⁾. However, instances of poor workmanship and material selection still occur. A further step change in quality control is needed to get the poorest performing flooring contractors up to the standards of the best. The purpose of this article is to provide encouragement to main contractors to grasp the quality nettle and to provide some advice on the key areas to control.

TONY HULETT, FACE CONSULTANTS

For too long many main contractors have sat on the sidelines, letting the specialist subcontractor 'get on with it'. There appears to be a perception on the part of some main contractors that the processes of floor construction are complex and indeed 'specialist'. This might fairly apply to the equipment used such as the laser screeds and to the finishing processes. In contrast, other aspects such as sub-base construction, concrete procurement and measurement are relatively straightforward.

Sub-base construction

TR34 is quite clear on the requirements for the construction of sub-bases. The primary purpose of the sub-base is to support the weight of construction traffic, which in

practice means concrete truck mixers. Sub-base materials should therefore be of a suitable grading and moisture content so as to obtain optimum compaction. Proof loading of the sub-base with a loaded truck mixer is a simple method of measuring performance. This should be done before an area to be cast is approved.

It is of great importance that the sub-base finished level, which is the soffit former for the slab, does not compromise the thickness of the slab. TR34 along with other guidance is also quite clear on this, requiring a +0/-25 tolerance on the sub-base. This upper limit of zero tolerance is of greater significance than might be appreciated.

Specialist contractors are easily capable of laying sub-base levels within a range of 10mm from high to low spots. It follows that in order to comply with the TR34 requirement they should budget for 5mm of concrete extra to the nominal requirements of the slab thickness.

Experience has shown that many contractors are reluctant to do this. Despite the requirements, contractor proposals are often found with ± 10 mm on sub-base levels despite purporting to be compliant with TR34. Also seen are specifications such as 'between +5mm and -10mm with an average of -5mm'. On the face of it this sounds reasonable, but when it comes to checking the sub-base, how and who will assess the average?

Experience also shows that whenever a positive tolerance is allowed, then the slab will be thinner by that amount. The practical simplicity of a +zero tolerance is that for a surveyor it is easy to measure and control and should be seen literally as a line in the sand that will not be crossed.

Main contractors are advised to scrutinise proposals carefully and to deal with this matter at tender stage. A level playing field is needed between those tendering. Sub-base levels should then be routinely checked using an

"Experience also shows that whenever a positive tolerance is allowed, then the slab will be thinner by that amount. The practical simplicity of a +zero tolerance is that for a surveyor it is easy to measure and control and should be seen literally as a line in the sand that will not be crossed."



Figure 2 above: Steel joint assembly.

Figure 3 right: Failed Delta joint.

Figure 4 below: Defined movement profilegraph.



engineer's precise level on a 3m grid that is approximated by pacing.

Concrete

Control of concrete quality should be straightforward when delivered by a ready-mixed concrete supplier with a recognised quality scheme. However, admixtures and/or water are often added on-site and the main contractor should ensure that records of such additions are maintained.

The concrete volume used in a floor should equate to the theoretical volume shown on the drawings plus an average of 5mm as discussed above.

Evidence suggests that some flooring contractors will also attempt to save on concrete by not meeting the target finished floor level (FFL). The allowance in TR34 for a maximum variation of $\pm 15\text{mm}$ on FFL is intended for the up and down variations in level. The mean level should meet the FFL on the drawings.

Reinforcement

Steel fabric will normally be covered by a UK CARES certificate. It is easy to see that it is of the correct grade and that it is correctly placed with the required cover and laps.

Steel fibre additions are in contrast 'relatively invisible' and are not covered by a quality scheme. Measures should therefore be put in place to ensure that the fibre content is controlled by both fibre wash-out tests and a rigorous stock control system that checks that the correct quantity of fibres is delivered to site and used.

When designs for floors are submitted, the engineer should request proof that the claimed fibre-reinforced concrete properties are proven. Fibre procurement and delivery documentation should then be checked to demonstrate compliance.

Joints

In recent years, most floors have been constructed using steel formwork, which performs the dual functions of forming the edges of each section of concrete poured and providing stay-in-place edge protection for the joints.

These joints have become known by their proprietary names such as Alpha joints, Omega and Delta joints. The term Alpha joint has become a generic descriptor for discrete plate dowels although there are a number of manufacturers of these systems. This type of joint is the most commonly used and has largely replaced the Omega or Delta joints which were continuous plate dowels.

There is good reason for this as continuous plate dowels are prone to break out as can be seen in Figure 3. Once these have failed in this way, they are very difficult to repair and often have to be removed in their entirety. Omega and Delta joints also tend to have steel section thicknesses that are limited to 5mm, whereas the norm for joint protection is 10mm.

Main contractors are advised to check the proposed joint details at tender stage. At construction, care and attention to detail is required to ensure that the joints are correctly assembled and levelled. Poorly assembled connections in the joints and intersections with sawn joints are a common source of problems.

Surface regularity

There has been much debate in recent years about the methods for measuring floors and particularly floors for very narrow aisle (VNA) installations in warehouses. Some flooring contractors resisted the requirement to control the flatness in all of the wheel tracks, but happily, common sense has prevailed and the new European Standard requires that all wheel tracks should be considered.



Figure 5: Measuring property II.

This debate has overshadowed a much more fundamental requirement, which is to measure free movement areas to a common Standard. Although TR34 has prescribed these requirements for many years, they are routinely ignored by some flooring contractors and their surveyors.

Although the requirements for free movement areas are generally not onerous, free movement specifications are routinely used in developments where a VNA layout has not been provided or is not planned in the initial use of the building.

However, it can be anticipated that the floor might be used for VNA at some time in the future and it has become common practice to specify a floor that meets TR34 Classification FM2 Special in the anticipation that such a floor would require minimal or only modest grinding to bring it up to a defined movement specification such as DM2 or even DM1.

This is sound practice as it has been shown that FM2 Special is readily achievable at no extra cost and some contractors are routinely bettering this Standard. It is interesting to note that FM2 Special was introduced in the Third Edition in 2003. It is almost identical to the FM2 from the Second Edition, which had been relaxed in the 1997 Supplement.

The question remains as to whether the client knows what it is getting. The answer is that in many cases it probably does not because the floors are routinely not being surveyed correctly and main contractors are probably unaware of the problem. If they were to critically examine the survey methods and reports they might find that the following is typical:

- The 3m grids are not measured and marked but are approximated by pacing.
- Grid start positions are not marked, making the survey not repeatable.
- Grids are approximated in relation to column centres and mid-spans, giving grids of 4m or more instead of the prescribed 3m.
- Tables of what might be presumed to be raw levels are presented with no explanation and no calculation of level differences between adjacent points as required.
- Large areas of floor are not surveyed.

- Levels are not related to the finished floor level datum and are therefore not repeatable.
- Numerous Property II runs are claimed to have been taken, all of which show full compliance, but the data is not provided. When the data is requested, it seems to be unavailable.

Why does all this matter? Many contractors are capable of producing very good quality floors that would require only modest grinding to upgrade to VNA requirements. Other contractors are building floors of questionable quality and passing them off with dubious surveys. Surely, this is not acceptable.

The industry needs to wake up to these problems. There can be no justification for including these surveys in the flooring contractor's package, with main contractors treating this as just a box-ticking exercise. Surveys should ideally be commissioned by the client's representative. If not then the main contractor should do this. Surveys should be undertaken by a UKAS or similarly accredited surveyor.

Concluding remarks

Many of the basic aspects of floor construction are not complicated and should be well within the grasp of competent main contractors.

Main contractors should be supervising floor construction to ensure that standards are improved and compliance with specifications is achieved. Making sure that a floor is of the required thickness, with the correct concrete and reinforcement and the required flatness and levels, is not rocket science.

This process begins when tender proposals are received and ends when the floor is completed and properly certified as being compliant. ■

“Main contractors should be supervising floor construction to ensure that standards are improved and compliance with specifications is achieved. Making sure that a floor is of the required thickness, with the correct concrete and reinforcement and the required flatness and levels, is not rocket science.”

Reference:

1. CONCRETE SOCIETY. *Concrete Industrial Ground Floors – A guide to their design and construction.* Technical Report 34, Third Edition, Camberley, 2003.