SPECIFYING INDUSTRIAL CONCRETE FLOORS & PAVEMENTS


INTRODUCTION

The concrete floor is one of the most crucial elements of an industrial building, providing the operating surface on which pallets are stacked, forklifts are operated and racks are installed. There are a myriad of ways to design and build a concrete floor, a multitude of finishes to choose from, a variety of reinforcing types to think about, countless curing methods to consider and endless ways to detail and locate joints. Variety is the spice of life, but unfortunately it creates a conundrum for the industry – for not all floors are created equal. To aid in the design and construction of quality floors MSC Consulting Group, JAWA Structures and Conslab have produced a suggested specification for use by industry professionals. This paper discusses the principal considerations when specifying an industrial concrete floor and can also be considered a commentary on the appended specification.

FLOOR TYPE AND DESIGN

Floor Type

There are a variety of methodologies for designing, detailing and reinforcing an industrial concrete floor. In New Zealand industrial floors are predominantly mesh reinforced, steel fibre reinforced, or post-tensioned. Other less popular options include floors incorporating shrinkage compensating concrete, and unreinforced or semi-reinforced floors. Each type of floor offers different characteristics in terms of performance, construction costs and likely future maintenance requirements.

The type of floor selected for a project will depend largely on the design loading, subgrade conditions, the clients budget and expectations for flatness, joint layout, surface appearance, serviceability and future maintenance requirements. As such it is difficult to provide a one size fits all recommendation on which type of floor to specify.

Most performance and maintenance issues in industrial floors occur at saw cut and formed joints. These are the areas that are most likely to become damaged and are also the areas most likely to interfere with the smooth operation of material handling equipment. It can therefore be extremely beneficial to look to minimize or completely eliminate the presence of these joints in a floor. This is achievable using both “joint free” steel fibre reinforced, post-tensioned floors.

Floor Design

The most predominant method for the of design concrete floors in New Zealand is presented in the CCANZ TM38 guide “Concrete Ground Floors & Pavements for Commercial and Industrial Use, Part Two: Specific Design”. This approach is based on the work of Westergaard. It is important to note that this approach assumes an unreinforced slab for structural purposes – steel mesh, bar or steel fibre reinforcement is not considered to act to resist loads – it is merely incorporated to control crack widths.

An alternative is the use of yield line analysis for the design of industrial concrete floors. This approach was first developed by Meyerhof and later Losberg. In New Zealand the yield line analysis approach to floor design is typically only employed by steel fibre suppliers, however it should be noted that it is the predominant approach to designing floors in the United Kingdom, where it is applied to floors reinforced with both steel fibre and mesh reinforcement.

Industrial concrete floors are generally subjected to the following load types:

- Point loads from the legs of storage racks.
- Wheel loads from fork lift or reach trucks moving in either random or defined directions in the aisles or open areas of the floor.
- Wheel loads from trucks delivering product into the warehouse.
- Product stored direct on the floor e.g. heavy cartons, pallets, bales or paper rolls.

A more detailed discussion of concrete floor design is outside of the scope of this paper, however it is worth noting that with the advent of specialist concrete flooring firms in New Zealand it is now possible for industry professionals to “outsource” the design of floors using design/build contracts.
SUBGRADE AND SUBBASE FORMATION
The structural integrity of the layers beneath a ground supported slab is of vital importance to the long term bearing capacity and serviceability of the slab. This section discusses:
- The rationale for assessing the load bearing capacity of the subgrades
- Subgrade investigation and testing
- Subgrade construction

Assessing the load by capacity of the subgrade
The design of industrial concrete floors generally assume that the subgrade is an elastic medium whose elasticity can be characterised by the force that, distributed over unit area, will give a deflection equal to unity. Westergaard termed this soil characteristic the ‘modulus of subgrade reaction’, k, i.e. the load per unit area causing unit deflection, with the units N/mm². The modulus of subgrade reaction is sometimes referred to as a resilience modulus and, in simple terms, the subgrade may be considered to act as if it were rows of closely spaced but independent elastic springs. Thus, the modulus of subgrade reaction is equivalent to a spring constant and is a measure of the stiffness of the subgrade.

A detailed discussion of k values is given in the comprehensive 1995 NCHRP Report 372, Support under Portland cement concrete pavements. The report makes the important recommendations that the elastic k value measured on the subgrade is the appropriate input for design.

NCHRP Report 372 confirms that the k value has only a minor effect on slab thickness design for flexural stresses and does not, therefore, need to be estimated with great accuracy. The results in Table 1 below are taken from Report 372 and show that errors up to a value of 50% have a relatively small effect on slab thickness design. It should be noted however that deflections are more sensitive to k values.

<table>
<thead>
<tr>
<th>Error in k value, %</th>
<th>Typical maximum error in slab thickness, %</th>
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<tbody>
<tr>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>25</td>
<td>2.5</td>
</tr>
<tr>
<td>50</td>
<td>5</td>
</tr>
</tbody>
</table>

Subgrade investigation and testing
Materials at deeper levels below the ground surface have their most significant effect on the long-term settlement of the slab. For a loaded floor, the bulb of pressure under loads will extend its influence to a depth well into, and possibly beyond, the subgrade or filled areas. There is therefore the potential for long-term settlements to be much larger than the elastic deflections calculated as part of the slab design. This effect could result in differential settlement between heavily and lightly loaded areas, with a consequent effect on floor surface regularity.

Materials closer to the ground surface have more effect on the measured subgrade properties than those at larger depths. The near-to-surface property of the subgrade that is used in the thickness design of a slab is the modulus of subgrade reaction, k.

Elastic k values do not reflect long-term settlements due to soil consolidation under loading. However, low values of k are indicative of plastic behaviour of the near-to-surface soils. Checks should be made on the likely deformation of the subgrade, particularly for soils with low k values.

To estimate long-term or differential settlements a geotechnical engineer should be consulted with regard to appropriate site investigation, soil testing and interpretation.

California Bearing Ratio (CBR) tests are sometimes used to assess soils performance although the results are less representative of long-term potential soils performance. Figure 1 below shows the approximate relationship between CBR and k values. The CBR is the ratio of resistance to penetration developed by a subgrade soil to that developed by a specimen of standard crushed rock. The test was developed as a laboratory test, but where used, determination of CBR should be carried out in situ.

![Figure 1: Relationship between modulus of subgrade reaction and in situ CBR.](image)
In some cases reliance will be placed on an assessment of $k$ based on soil types. Table 2 gives below gives an indication of typical values of $k$ related to soil type.

**Table 2: Typical values of modulus of subgrade reaction $k$ related to soil type.**

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>$k$ value (N/mm$^3$)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Lower value</td>
</tr>
<tr>
<td>Fine or slightly compacted sand</td>
<td>0.015</td>
</tr>
<tr>
<td>Well compacted sand</td>
<td>0.05</td>
</tr>
<tr>
<td>Very well compacted sand</td>
<td>0.10</td>
</tr>
<tr>
<td>Loam or clay (moist)</td>
<td>0.03</td>
</tr>
<tr>
<td>Loam or clay (dry)</td>
<td>0.08</td>
</tr>
<tr>
<td>Clay with sand</td>
<td>0.08</td>
</tr>
<tr>
<td>Crushed stone with sand</td>
<td>0.10</td>
</tr>
<tr>
<td>Coarse crushed stone</td>
<td>0.20</td>
</tr>
<tr>
<td>Well compacted crushed stone</td>
<td>0.20</td>
</tr>
</tbody>
</table>

**Subgrade Preparation**

The design of the slab thickness is not particularly sensitive to the thickness of the subbase material; accordingly the as built level at the top of the subgrade can have a degree of tolerance. We consider that an appropriate and realistically achievable tolerance is +/- 25 mm at subgrade level. The thickness of base course chosen is fairly nominal and we normally specify 150mm to 200mm depending on the condition of the subgrade. This is a judgment call on the part of the Engineer depending on the expected condition of the subgrade, availability of suitable economical metals and possibly the expected time of the year construction may take place.

We consider it prudent that for the record and to ensure the correct levels are constructed a competent surveyor be engaged after construction of the subgrade to provide an as built levels plan to the Engineer.

On completion of the subgrade formation testing of the subgrade should take place to verify the value of modulus of subgrade reaction, $k$, used in the design. This testing should be carried out under the observation of either the project Geotechnical Engineer or the project Design Engineer and will generally comprise either, plate loading tests, Scala Penetrometer tests or Benkelman Beam testing depending on the type of subgrade.

**Testing of subgrades in Cut**

Particularly if the subgrade is clayey, as for most of New Zealand, then we recommend that the testing be carried out at a level approximately a nominal 50mm above the final subgrade level. This is up to the Engineer and Contractor on site but suggested because in clayey soils the process of testing particularly with a Benkelman Beam truck, can damage the surface.

Following approval of the test results final trimming to subgrade level can be completed or if the results are not acceptable decisions can be made to either undercut or possibly stabilize the surface to achieve the required strength.

**Testing of subgrade in Fill**

Where filling the site is required then the compacted fill material should be placed up to the design subgrade level. At that stage the subgrade testing should be carried out to determine the $k$ value of the construction subgrade as confirmation for the Engineers’ decision.

**Subbase Formation**

Subbases are usually constructed from stable, well graded granular material complying with and laid in accordance with Transit NZ specifications. Cement stabilised subases are also occasionally used.

Where other types of subbase are used, such as cement bound materials, then if advantage is to be taken in respect of load-carrying capacity of the floor, an alternative form of analysis maybe required that is beyond the scope of the guidance in this paper.

If granular material is used, the subbase should have a minimum thickness of 150 mm.
Where a soils survey has shown the subgrade to be adequate to provide support directly to the slab (e.g. a granular material with k more than 150) it may be appropriate to lay the slab directly on the subgrade. However, the effects of plant movement and weather conditions must be taken into account when considering the omission of a subbase.

Checks should be made to ensure that subbase materials do not produce deleterious products likely to attack the concrete chemically nor expand or contract excessively with moisture movement.

Of particular importance for the construction and performance of the slab is the fact that the surface of the subbase should be well closed and free from movement under compaction plant and from ridges, cracks, loose material, potholes, ruts or other defects.

Any trimming of the surface should leave the subbase homogenous and well compacted. Trimming layers cannot make up for deficiencies in the subbase construction. A sand binding layer should not be used. Sand may be used for closing the surface of coarser grained materials but any residual layer of sand at the surface should not be more than 5mm thick.

Research has shown that a compacted granular subbase only marginally enhances the ability of the subgrade to support the concrete slab and its loads. Any enhancement of the modulus of subgrade reaction produced by a compacted granular subbase is so small that, compared with the variations in properties that will occur in a natural soil, it should be neglected in the design process. The modulus of subgrade reaction should always, therefore be measured on the subgrade. However, this does not remove the need for good subbase construction practice.

Subbase Surface Tolerance
It is essential to minimize the risk that the slab top level and subbase top surface are both out of tolerance at the same point and in the adverse direction as this may reduce the thickness of the concrete slab so much that its load-carrying capacity is reduced to an unacceptable extent. Therefore, the finished surface of the subbase should be within +0 to -25 mm of the datum for the bottom of the slab in accordance with BS 8204-2. Construction of the subbase to tighter tolerances should be encouraged as this reduces wastage and provides a flatter subbase. Positive tolerance above zero datum should not be permitted as these will directly effect the thickness of the slab. Subbase finished levels should be surveyed at an appropriate number of points. It will be beneficial if these survey points coincide with a planned grid of survey points for the top level of the slab, to verify the actual slab thickness.

Our recommendation is that the top surface of the subbase should be placed to achieve a tolerance of +0 mm or -10 mm, this should be measured on the completed blinded surface. We are now specifying that a Registered Surveyor be engaged at this stage to produce an as built plan and certification that these tolerances have been achieved. This tolerance is quite achievable however, laser guided equipment will generally be required.

Figure 3: Subbase finished levels are surveyed

UNDER FLOOR MEMBRANE
The main purposes of an under floor membrane is to provide:

- Resistance to rising damp
- Reduction in friction between the slab membrane and the subbase surface.

Membranes are normally plastic sheeting to comply with the N.Z Standard Building Code. NZS 3604 clause 7.5.4.2 seems to be the most comprehensive guideline.

It is important to lay the membrane without creases and overlapped at the edges by at least 300mm, and to ensure that it is not damaged during the construction process. The plastic sheet will inhibit the loss of water and fines from the concrete to the subbase and can, where required act as a water vapour resistant membrane.

It is worth noting that specialist gas membranes and venting systems are becoming more common as more and more construction is carried out on contaminated land.
FLOOR SURFACE REGULARITY

Importance of surface regularity
The concrete floor in a warehouse provides the surface on which material handling equipment (MHE) operates. As such the surface regularity of the floor can impact on both equipment productivity and safety. Inappropriate surface regularity can also lead to increased maintenance costs for material handling equipment by increasing the stresses created in the vehicles mast and body. Other issues include increased driver fatigue, and the disruption of electronic sensor equipment in sophisticated wire guided MHE, where a vehicle can sway outside of the range of its guidance wire. The influence of floor surface regularity on MHE operation can be well illustrated by considering static lean - whereby any variation in floor level between MHE wheel tracks will be magnified at the top of the mast, proportional to its height. Figure 4 below, taken from the third edition of UK Concrete Society Technical Report (TR) 34, demonstrates this concept – a 2.5 mm difference in elevation across wheel tracks translates into a 20 mm eccentricity in the vehicle.

This effect can be magnified by a factor of 3 -4 times by dynamic movements.

Different types of floor area
Different MHE operating environments call for different standards of floor surface regularity.

Typically floors should be divided into two distinct classifications for this purpose - free-movement traffic areas and defined movement traffic areas. It should be noted that a single warehouse development could combine both free warehouse and defined movement areas.

Free Movement Areas
In free-movement areas MHE can travel randomly in any direction. Most industrial concrete floors in New Zealand could be described as free movement floors. In warehousing applications, free movement floors typically have wide aisles racking, with MHE generally operating with loads at a low level. The risk of MHE colliding with storage at a high level as a result of an uneven floor is therefore low, so less control of surface regularity is required compared to a defined movement area.

Defined Movement Areas
In defined movement areas MHE travel using fixed paths. Defined Movement areas are normally only seen in specialists facilities, which incorporate high racking, very narrow aisles, and wire guided or man up type equipment. Historically very few defined movement warehouses have been constructed in New Zealand, however recently we have noted a marked increase in the number of facilities requiring defined movement floors.

The surface regularity of a defined movement area is extremely important to the operation of these facilities, and so must be controlled to a much higher standard than for a free movement floor.
Typical New Zealand Specification
A typical warehouse specification in New Zealand calls for the surface regularity of the floor to be controlled by NZS 3109 “Concrete Construction” and NZS 3114 “Specification for Concrete Surface Finishes”. NZS 3109 provides tolerances to ensure that structural performance is not compromised, and does not touch on the serviceability/performance of the floor.

NZS 3114 provides surface regularity tolerances for 11 different surface finish classes named U1 – U11. The tolerances are based on the use of 3 m long straight edge to measure the difference in elevation between any two points within its length. These values are called “gradual variations” and are limited to a maximum value given for each class of finish and its end use. Figure 7 below, taken from NZS 3114, demonstrates the definition of a “gradual variation”.

Deficiencies with typical specification
There are many deficiencies inherent to the “straight edge” method of testing required by NZS 3114. Specifically:

- It is not practical to measure large areas of floor.
- It is difficult to randomly measure a floor.
- It is difficult to reproduce test results.
- The method does not predict the acceptability of roughness or inconsistencies in a floor. It only measures the amplitude of irregularities, but the frequency of irregularities also influences MHE performance.

Because of the impracticality of measuring floors using the straight edge methodology prescribed by NZS 3114 floors in New Zealand are seldom tested for conformance to specification. While the lack of conformance testing makes specifications
meaningless, it has also developed the misconception that the “3 mm within a 3 m straight edge” is an easily achieved specification – the standard New Zealand floor. In reality this specification is not readily achievable using normal wide bay floor construction methods, and very few industrial concrete floors constructed in New Zealand would achieve this specification.

The myth of the “3 mm in 3 m floor” is perpetuated by placing and finishing contractors who do not carry out regular measurements of their own floors and are unaware of how well they really perform. Contractors also understand that the specification won’t be tested unless control of floor surface regularity is particularly bad. An example of this would be when the cost of installing racking increase dramatically to cater for the poor levelness of a floor.

Clearly the current New Zealand practice of specifying floors to NZS 3114 standards, does not allow for accurate control of a floor surface regularity. As has been demonstrated, “straight edge” methods are inherently flawed, and enforcing NZS 3114 type specifications would be difficult and impractical.

Several superior methods for specifying floor surface regularity exist overseas. These include the F-number system in the USA, the guidelines in the UK Concrete Society document TR34, and the draft Eurocode prEN 15620.

Our recommendation is the adoption of the new Eurocode prEN 15620 for specifying floor surface tolerances. This approach is discussed below.

**Eurocode specification of free movement floors**

The new prEN 15620 outlines a simple but effective method for controlling the flatness of an industrial concrete floor. The elevation of points set out on a 3 m by 3 m grid on the floor are measured using an accurate level and staff. The standard deviation of the difference in elevation between the points is then calculated. The code provides limiting values for this standard deviation for different floor classifications. These are reproduced in the appended specification.
Eurocode Specification of defined movement floors

Defined movement floors, where MHE travel along a singled fixed path, require tighter control of floor surface regularity than free-movement floors, and require different surveying methods be employed. The guidelines in prEN 15620 require the wheel path of the MHE to be measured for every aisle on the floor. This contrasts with the measurement of free-movement floors, where only a sample of the floor is tested.

Clearly a defined movement specification cannot be used unless aisle locations are known prior to the floor being constructed. If this is not possible it may be necessary to produce a floor with very tight free movement tolerances, and then undertake grinding to achieve the desired result in aisles once there location is known.

Measurements for defined movement floors are taken using a device called a profileograph. A profileograph is a proprietary device that can be described as “self propelled level sensing instrument”.

Profileographs typically take measurements at 50 mm intervals, thereby effectively providing data for 100% of measurable points along a path. The change in elevation is controlled along the wheel tracks, across the wheel tracks, and between the front and back axle.

The code provides limiting values for these properties based on the floor classification and the dimensions of the material handling equipment. These are reproduced in the amended specification.

Note that the method of measuring floor flatness and the limits imposed by prEN 15620 are consistent with other defined movement specifications such as the F min system in the USA.

Remediation for out of tolerance floors

The appropriate action to take when a floor is measured and found to be out of tolerance is largely dependent on whether a floor is a free or defined movement area. Decisions about how a floor may be remedied if it fails to achieve specification should be made prior to construction.

Free-movement areas

Because MHE can move on an almost infinite number of wheel paths in a free movement area it can be difficult to “correct” an out of tolerance floor by grinding. It is also prohibitively expensive to remove and replace a floor that fails to achieve specification. As such it is suggested that a
pragmatic approach is taken when a free-movement floor has failed to meet specification – for instance a small number of out of specification areas on a floor are unlikely to significantly impact the floors productivity.

**Defined Movement areas**

Defined movement floors that are constructed out of specification can be remedied through grinding along the wheel tracks of MHE. It is suggested that laser guided grinding is the best method of bringing a defined movement floor into specification, as it is exceedingly difficult to effectively grind a wheel track to the necessary level of accuracy manually. Some defined movement floors are constructed with the intention of being ground into specification; however this will not necessarily give the client the best result. In particular grinding a floor removes the dense top surface, reducing the abrasion resistance. Grinding also impacts negatively on the appearance of the floor.

The finished appearance of the floor is extremely crucial to client satisfaction. No matter how well other aspects of the project are executed a poorly finished floor will negatively impact on the clients opinion of the quality of the entire warehouse. No specification can be sufficiently accurate as to the actual timing of most finishing operations. As such only experienced placing and finishing contractors with the necessary plant and equipment should be engaged to produce an industrial concrete floor.

**JOINTS**

Formed and saw cut joints are unavoidable elements in many concrete floors and their design and construction require careful attention because they can be significant potential source of problems. The edges of slab panels are vulnerable to damage caused by the passage of materials handling equipment with the wider joints being more susceptible. The small hard wheels on pallet trucks and similar fork hoist trucks are particularly aggressive.

The number and type of joints in a floor will depend on the floor construction method and its design. The method chosen should be related to the planned use of the floor and other factors. For example long strip construction may have to be used where a very flat floor is required for defined movements of high lift aisle trucks.

In New Zealand we now have a very good choice of excellent joint hardware suppliers and these companies should be consulted early in the design stage to discuss the requirements and options available. The discussions and advice contained in Chapter 8 of Technical Report No. 34 from the Concrete Society is also an excellent source.

As a general rule we would suggest that “the fewer number of joints and saw cuts the better” because each joint has the potential for required maintenance or remediation in the future. This philosophy has been appreciated by clients, owners and users, and has lead to a more widespread use jointless steel fibre reinforced floors and post tensioned floors.

**CURING AND SEALING**

After the use of correct placing and finishing techniques, and quality concrete, curing is the most important factor in achieving a quality floor. Correct curing slows the moisture loss of the floor allowing more complete hydration of the cement. In particular this will effect the abrasion resistance of the floor. Curing will also reduce early carbonation of the floors surface.

Industrial concrete floors should either be water cured, or cured using an NZS3109 compliant curing compound. Liquid surface treatments, such
as sodium and lithium silicates, should not be used for curing concrete. To quote the American Concrete Institute report 302.1R-04 “Products in this group are not specifically formulated for curing applications and do not meet the requirements of either ASTM C 309 or ASTM C 1315 for liquid membrane-forming compounds. While their use may offer some desirable benefits when applied after curing, they should not be applied on fresh concrete”.

**Water Curing**
The floor should be water cured for a minimum of 7 days. While this can be achieved by ponding, sprinkling or fogging the slab, the most practical method of water curing is to cover the floor with polythene sheeting as soon as possible after finishing operations.

Be aware that polythene curing will cause staining on the surface of the floor. This will become significantly less noticeable with time. Polythene can become extremely slippery when wet, and so all trades should be aware of the health and safety implications of working on a floor that is covered with polythene.

**Liquid Membrane Forming Curing Compounds**
Liquid membrane forming curing compounds are a widely accepted method for curing concrete floors, particularly in the USA and UK where they are the most common method of curing industrial floor. A curing compound offers some key advantages over water curing, particularly because they offer a long uninterrupted curing time when compared to the 7 day curing typically achieved with water curing.

They will also not stain the floor in the same way polythene sheeting will, and depending on the compound chosen can actually enhance the early age appearance of the floor by providing a dark and glossy finish. Disadvantages of the use of a liquid membrane forming curing compound include issues with achieving an adequate and even coverage, and the potential to interfere with applied coverings and liquid surface treatments such as sodium silicates.

The compound chosen should meet or exceed the moisture retention requirements of ASTM C309, which will ensure that it complies with NZS3109 requirements for curing. It should be applied as soon as finishing operations are completed, while the surface is still damp but free of standing water.

**LIQUID SURFACE TREATMENTS**
There are currently a variety of concrete liquid surface treatments on the market in New Zealand, the majority of which are sodium or lithium silicate treatments. The products are generally marketed for use as a means for dust proofing and hardening the surface of a floor, and also for improving the appearance of the surface.

It should be noted that the anti dust and abrasion resistance properties of the floor will be predominantly determined by use of:

- Correct placing and finishing techniques using ride on power trowels.
- An adequate concrete strength (35 or 40 MPa is suggested, with a minimum cement content of 325 kg/m³).
- Correct curing.

Performed correctly these “fundamentals” of floor construction will produce a floor free of dusting with AR2 abrasion resistance, suitable for the majority of facilities. Very little else will impact the anti-dust and abrasion resistance properties of the floor significantly. Consequently, the use of a liquid surface treatment should not be considered as a remedy for poor placing and finishing, low concrete strength or poor curing.

Furthermore, if the floor is well constructed the liquid surface treatment is unlikely to lift the abrasion resistance of the floor into a superior category such as AR1 or Special – which would typically require the use of a dry shake surface hardener. As such we would not recommend specifying a liquid surface treatment on the grounds of preventing dusting or hardening the surface.

Historically the use of a liquid surface treatment to improve the appearance of the floor has been extremely subjective, making it difficult for industry professionals to quantify the effect of specifying
the products, or even to fairly evaluate different products. This has begun to change in the USA, where gloss meters are being used to measure the “gloss numbers” of floors constructed in various ways and with various surface treatments. A gloss number is essentially a measurement of the light reflectivity of a surface. The concept has been in use for some time in other industries – for instance gloss meters are used in the automobile industry to compare the “shine” of different types of paint.

Large retailers such as Wal-Mart have begun using this technique to provide a quantifiable specification for the appearance of the floor. Increasing the reflectivity of a floor has the key benefit of reducing the amount of lighting required in a store, thereby reducing energy consumption. Based on gloss metre readings some liquid surface treatments have been shown to significantly increase the reflectivity of a floor. Currently this approach to specifying floor properties has not been trialled locally, however it has some strong merits and we anticipate that this process could find its way into the New Zealand market in the near future.

PROTECTING THE FLOOR AFTER POURING

The new floor should be left undisturbed for a minimum of three days following pouring to allow the concrete to harden enough to avoid damage to the surface or at joints. In cold weather the floor may need to be left longer than three days. After this period pedestrian access to the floor could be permitted, however it has some strong merits and we anticipate that this process could find its way into the New Zealand market in the near future.

A copy of this specification is appended to this paper and we recommend that you consider its use, albeit modified to your own requirements or tolerance.