

Pick the right surface and avoid any slip-up – for ever

Fifteen years ago Permaban discovered that the slip resistance of floors hardened with alloy-based dry-shake floor hardener is better after several years in use than a new floor surface. Although perhaps counter-intuitive, it is actually the case that various aspects of good-quality new power-floated concrete floors improve with age and usage. These include the appearance of the floor and could include its slip resistance properties provided the surface incorporates the appropriate fine aggregate. **Andrew Mackenzie** of Permaban reports.

The Health and Safety Executive advises that a floor surface should have a minimum profile (R_p) of 10 to 20 microns in order to reduce slipping problems⁽¹⁾. Operational factors should also be taken into account (eg, whether the floor will be clean or dirty, dry or wet). In addition, the nature of the particles exposed in the surface is very important as the surface in wet or contaminated conditions must grip rather than act like ball-bearings.

Clean and dry, good-quality power-floated concrete floor surfaces tend not to exhibit slip-resistance difficulties. Problems arise when the floor is wet or contaminated. It may be that the contamination (as in the example below at Carcraft, Leeds) is invisible.

Materials incorporated in the surface profile

Surface profile can be measured in several ways and the method HSE found most useful was the R_p . This is the maximum peak height above the mean line across the displacement profile. As well as achieving an appropriate surface profile it is critical that the materials used are suitable. In this respect, angular crushed materials perform better than rounded fine aggregates. Also the angular fine aggregates must stay angular and not become rounded over time. There are two tests for aggregates relevant to this. One is the polished stone value (BS 812: Part 114⁽²⁾) and the other is the aggregate abrasion value (BS 812: Part 113⁽²⁾).

Polished stone value (PSV) is a measure of the slip resistance in wet conditions after abrading the aggregate. This is comparable to the pendulum slip resistance values (see Table 1) and should be as high as possible – certainly not less than 40.

Aggregate abrasion value (AAV) is a measure of the degree of abrasion that occurs during the aggregate test. The lower the value the more wear resistant is the aggregate. Typical comparison values are 18 for granite and 1.9 for emery. A low AAV indicates that the aggregate should not become rounded by operational use of the floor in which it is incorporated.

The PSV and AAV obtained for the alloy aggregate used by Permaban are 53 and 1.0 respectively.



Photo: Palforce Ltd

Methods of achieving the surface profile

The effect of normal operational use (natural ageing)

Permaban's early experience of the relevance of the surface profile came following observations of how slip resistance had developed and increased in Permashake Alloy floors over time and with normal operational use. Ten to 20 microns is not an obviously rough profile and only requires a modest amount of cement matrix (and possibly residual curing membrane) to be rubbed away. As the profile is relatively small this assists cleanability, making the surface easier to clean than bonded slip-resistant surfaces. This remains the way of achieving the profile that gives the most pleasing appearance. It is also clearly most cost-effective but the initial good slip resistance obviously has to be sufficient in all areas in the knowledge that it will get better still. It is possible to accelerate achievement of the beneficial effects of the

Figure 1 top: Surface texture of a lobby area in B&Q after the Permashake Alloy Light Grey surface was chemically aged by acid etching.

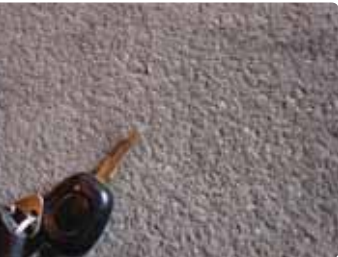
Figure 2 above: Showing a warehouse with the shot-blasted Permashake Alloy Natural floor in operation.

Table 1 – Permashake slip resistance test results

	Age	Condition	Surface roughness microns (Ave.)	Pendulum value dry (Ave.)	Pendulum value wet (Ave.)
Permashake Alloy	New	New	11	64	32
	New	Textured	32	58	61
	5 yrs	Trafficked	28	61	58
Permashake Quartz	New	New	9	62	29
	New	Textured	36	60	34
	8 yrs	Trafficked	30	49	33

* All tests were carried out after floor cleaning

** Taken from document Permashake – Slip Resistance Values



surface profile by artificial means (eg, chemical ageing and light shot-blasting).

Chemical ageing by acid etching

Figure 1 shows a close-up of the surface of a light grey Permashake Alloy floor in a B&Q lobby area. This floor was chemically aged for Permaban by Texturcare of North Walsham; 150 B&Q new store lobbies have now been treated this way. The main store areas are constructed using Permashake Quartz Light Grey, while the alloy grade is used in the lobby areas. Both areas are power-floated smooth. Chemical ageing is carried out only in the lobby areas. The reason for this is that the lobby areas can often become wet. This has been the standard treatment for these lobbies since 1999, when B&Q found that the traditional mats/wells previously used were actually proving to be a trip hazard and it sought a better solution.

Mechanical ageing by captive shot-blasting

Although, having indicated 10 to 20 microns as the minimum profile advised by HSE, clients operating road trucking operations on the floor (see Figure 2) have preferred a slightly deeper profile. An example is the 30,000m² state-of-the-art new terminal built in Burton-on-Trent for Palletforce and opened in 2009 by HRH The Princess Royal (see Figure 3).

To achieve this profile efficiently, captive shot-blasting has been employed. The blasting pressure, size of shot and number of passes can be adjusted but mostly 2mm round steel has been used with two passes. The shot is recovered magnetically and reused. Figure 4 shows a close-up of the surface texture of the warehouse floor after the Permashake Alloy Natural floor was shot-blasted.

Carcraft, Leeds

The other examples discussed in this article are from floors where the chemical or mechanical ageing process has been carried out on a new floor. However, provided the floor has been originally constructed using the alloy aggregate in the dry-shake concrete floor hardener, the process of accelerating the ageing/profile-developing can be done at any time in the life of the floor and alloy dry-shake floors are expected to have very long maintenance-free lives.

In 2003, a 6000m² vehicle showroom was constructed for Carcraft at Tingley, Leeds. The floor incorporated Permashake Quartz Light Grey. In addition the 1500m² new Vehicle Maintenance Workshop was constructed with Permashake Alloy Tile Red. The showroom and workshop floors continue to give excellent service (see Figure 5). However, in the valetting bay unexpected slip problems began to become evident. On investigation this was found to be caused by a silicone liquid applied to

refresh old tyre walls. Even in tiny quantities this liquid causes very low friction and led to slipperiness problems. Since the alloy aggregate had been incorporated into the floor surface, the remedy was straightforward. Permaban put forward Texturcare, who carried out the chemical ageing in the Valetting Bay. The resultant surface may be seen in close-up in Figure 6. On a recent visit by Permaban the Carcraft vehicle maintenance manager confirmed that it still has no slipperiness issues.

Durability

Dry-shake hardened power-floated concrete floors are exceptionally durable. There are many examples of floors continuing to give excellent service after 20 years in heavy-duty situations.

The profile discussed in this article is achieved monolithically within the concrete. The alloy aggregates are also a monolithic part of the concrete and thus the slip resistance achieved lasts for a very long time – unlike bonded anti-slip resin surfaces, which wear out like the texture on sandpaper. Obviously normal proper housekeeping must be carried out and this is straightforward in view of the modest profile needed.

Permaban is aware of no situations, even including some very heavy-duty applications over ten years old, where this slip resistance with alloy aggregate has worn out. Neither has one single client said that the modest extra cost involved in using alloy aggregate was a wasteful use of resources.

Aesthetics

The alloy aggregate is a bright silver-coloured material. These silver-coloured particles are not seen in the newly power-floated concrete surface but can be seen after a texture profile has been created (see Figures 1, 4 and 6). They do not detract from the appearance of the floor.

All power-floated concrete floors, properly cured and dry-shake hardened power-floated concrete floor surfaces when new are quite variable in tone. This relates to variability inherent in the drying out of the concrete slab itself. As a rule of thumb a concrete slab requires one day drying time per 1mm of slab thickness. A 175mm-thick slab will typically have six months drying time.

The most pleasing textured power-floated alloy dry hardened concrete floors are those where the texture has occurred through natural ageing. If the texture gain needs to be accelerated by artificial ageing this will result in more variability in appearance. This, though regrettable, is secondary to the building occupier having a safe and durable floor on which to carry on his business.

Long-term durable surface

Specifiers insisting on having an alloy aggregate dry-shake hardener incorporated into their floors provide their clients with a long-term durable and slip-resistant surface. In the event of unexpected problems from water, change of use or introduction of adverse contamination, there is a straightforward and low-cost solution giving that extra flexibility. After the event we have not known any client think the modest cost of the alloy aggregate involved wasn't worth it. ●

References

1. ROWLAND, F.J., BROUGHTON, R.A., RICHARDSON, M.T. and GRIFFITHS, R.S. *HSE Research into Slip Resistance of Floors*. H&S Laboratory of HSE, Sheffield, September 1994.
2. BRITISH STANDARDS INSTITUTION, BS 812. *Testing aggregates. Part 113 – Method for determination of aggregate abrasion value (AAV), Part 114 – Method for determination of the polished-stone value*. BSI, London, 1989, 1990.

FROM TOP:
 Figure 3: Floor (shown in Figure 2) being opened by HRH The Princess Royal.
 Figure 4: Surface texture of a warehouse floor after the Permashake Alloy Natural floor was shot blasted. Note some 2mm shot can be seen.
 Figure 5: General view of Permashake Alloy Tile Red floor surface in the vehicle maintenance workshop at Carcraft, Leeds.
 Figure 6: Close-up of Permashake Alloy Tile Red floor surface after chemical ageing by acid etching in the vehicle maintenance workshop valetting bay at Carcraft, Leeds.