Table of content

Does a reliable floor–drainage connection exist?

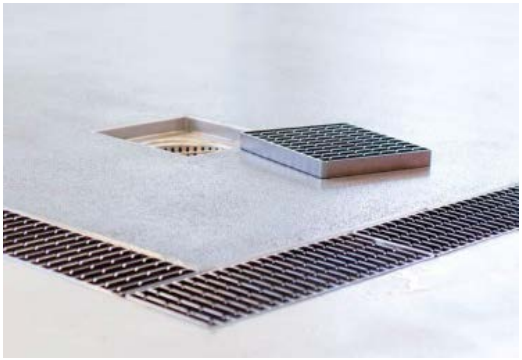


Figure 1 - Ideal example of drainage-floor connection

Fast-moving developments in hygienic resin flooring solutions and drainage systems are required to meet the challenging environments present in today's food and drink manufacturing industry. Individual systems are required to carefully balance the owner's varying requirements with regard to safety, hygiene and functionality. As with other elements of a processing factory's infrastructure, flooring and drainage systems can affect each other's performance. For example, the connection between the two is failing then the performance of both flooring and drainage can be compromised.

Until now, no proper study or research has taken place to investigate the behaviour of common floor-drainage connections and develop a precise design guideline. As a result, Sika – a market-leading resin flooring company, and ACO - a leader in the development and manufacture of hygienic drainage systems, joined forces and adopted a professional and scientific approach to this issue. A three year study and research program was commissioned to provide a clear evidence-based guidance with regard to flooring-drainage connections for factory and processing facility operators.

The industrial floor

Floor construction must meet several requirements with regard to safety and hygiene. The main requirements are water tightness, easy cleanability and high levels of resistance to common cleaning chemicals, dynamic impacts and thermal stress. The floor's surface must also be slip resistant to minimise the likelyhood of a slip accident occurring in the workplace. During its lifetime, the floor will be exposed to variety of elements that are potentially very damaging including hot oils, acidic solutions and organic substances like fat and blood. In addition, the floor will have to withstand cleaning and washing with hot steam and aggressive detergents so the ability of a floor to resist these factors is a critical consideration.

Items which are placed on or fitted into a floor such as machinery, trays and drainage can also increase the potential for flooring defects to occur. To prevent any defects occurring, the drainage specification must be considered with regard to the type of flooring specified and the features of it. There are a large variety of different flooring types and structures available on the market and flooring comes in a wide range of different thicknesses. Each factory floor will have a unique set of operating criteria, so it can be said that the same causes of defects may manifest differently on different floors and different causes of defects may manifest themselves on different floor. The most common floor defects include:

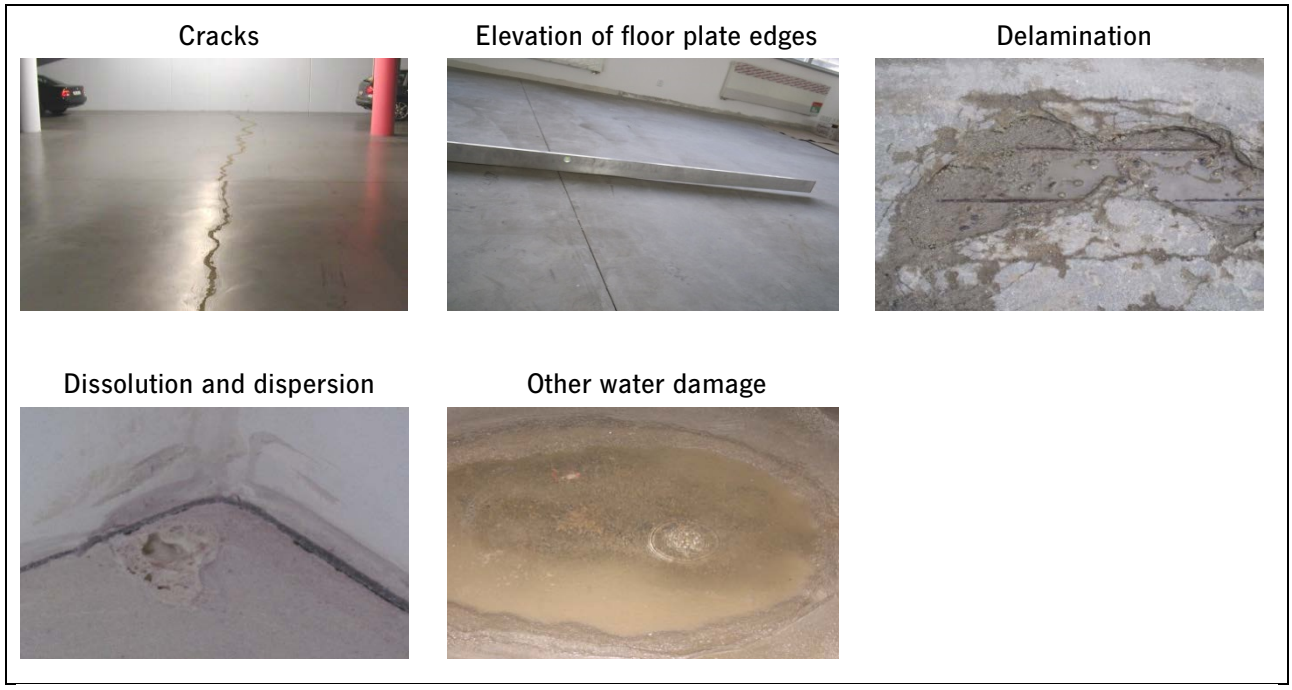


Figure 2 – Most common floor defects

The most common causes of defects are the specification of inappropriate drainage or a failure to consider specific environmental conditions.

Problem statement

Figure 3 - Flaws in the floor-drainage connection

The harsh manufacturing environment present in the food and drink industry poses significant stresses on the building envelope. This is especially true when it comes to resin flooring and stainless steel drainage systems which form an integral part of a factory floor. Failure in the flooring or drainage systems will lead to downtime in the production process and increasing costs. Today, specially developed resin flooring and stainless steel drainage solutions for the food and drinks manufacturing industry can withstand mechanical, chemical and thermal stresses. However, even when flooring and drainage systems are working well, failure often occurs in the connection between the two. It appears that no research or testing has taken place on this subject let alone the publication of a clear guidance with regard to specification.

Relevance to the food and drink industry

Total cost of ownership is one of the main concerns for the food and drink manufacturing industry, affecting many areas of the food production process. This concept also includes the building envelope and is particularly true for factory floors which are exposed to severe operating conditions. Production facilities also have to adhere to numerous legislative standards and requirements which are enforced by external regulators. Hence failure in a factory floor causes disruption to factory operations as well as compromising hygiene. This failure leads to downtime and the costs associated with it.

In order to avoid downtime resin flooring systems and hygienically designed drainage systems should be carefully selected for the different production areas with reference to the appropriate guidelines, research and testing results. As no guidelines currently exist in this regard, factory site operators currently have no option but to use trial and error when selecting flooring and drainage.

The scope and objective of research

Being confronted on a daily basis by issues caused by floor-drainage connections in food and drink production facilities, ACO and Sika decided to join forces and to commission a research and testing program. The objective was to be able to provide a guideline for the specification and installation of an effective connection between Sika resin flooring and ACO stainless steel drainage systems. There is a complex range of potential installation scenarios so ACO and Sika conducted research for the three main exposure scenarios that are most relevant to the food and drink processing industry:

- Mechanical exposure in areas experiencing heavy traffic from fork-lifts and/or hand-held pallet trucks.
- Thermal exposure from either the production process (i.e. frying or freezing) or the subsequent cleaning regime (i.e. pressure washing with jets of hot water).
- Shrinkage of the cementitious substrate (i.e. as seen with concrete, screeds, resin mortar installations).

For each of these scenarios a testing equipment has been developed to recreate these exposure scenarios to a high degree of accuracy.

Other requirements such as aesthetics, hygiene, cleanability and easy installation have been taken into account for the design of the floor-drainage connection. These requirements have had an influence on the design of the floor-drainage connection which was reflected in the various samples that were prepared and tested.

Figure 4 – Cut sections of few testing samples

The testing

The testing took place over 36 months and set out to determine the best optimal floor-drainage connection for specific environments. We have tested various drainage edge types with various floor types, enabling us to identify the best possible floor-drainage combinations.

Mechanical exposure testing

Figure 5 – WSTEC rig developed for mechanical exposure testing

For the purposes of mechanical exposure testing, ACO has developed a new testing rig. The testing rig is designed to determine the durability and resistance of grates, channels and their connection with floors which are exposed to dynamic loading. The rig enabled us to evaluate performance when different elements were exposed to loads generated by truck wheels of the type used on vehicles commonly used by the food and drink industry. We were able to vary the type of wheel, wheel loading and wheel speed during testing.

Technical parameters of testing rig:

Test wheel diameter:	82 mm
Test wheel width:	60 mm
Test wheel profile:	flat, almost line contact with the floor
Travel speed of the wheel:	750 mm/s
Vertical force:	2000 N
Number of cycles in one direction:	100,000 cycles

Wheel runs under load in one direction.

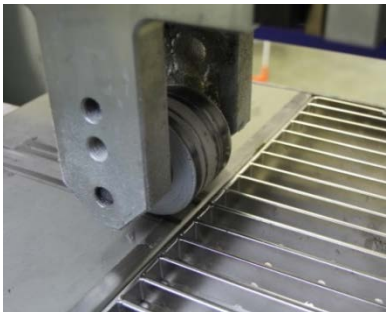


Figure 6 – Detail of edge-floor connection testing via WSTEC testing rig

Thermal exposure testing

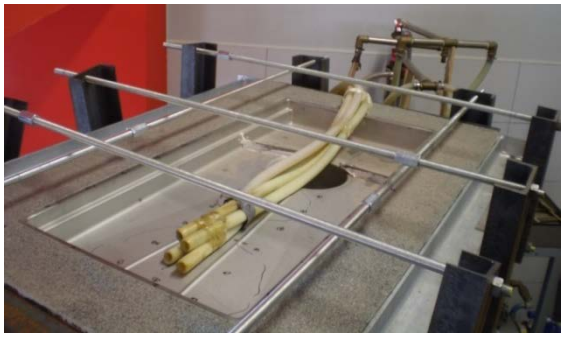


Figure 7 - Thermal testing rig

For this type of test, we have developed a testing rig that carries out standardised tests according to EN 1253. The test consists of hot and cold water cycles.

The hot and cold water circulates in samples of the installation channels which are housed in concrete blocks. Water circulates through the sample in predefined intervals. Hot water (90°C) is superseded by cold water (15°C) with a one minute break in between each cycle.

Shrinkage of cementitious substrate testing

Figure 8 – Detail of a tensile strength testing rig

To simulate concrete shrinkage, we used a testing rig provided by the Institute Tazus in Brno in the Czech Republic. The test was carried out to simulate a deformation from tensile strength.The tensile strength test machine has a graphic output which shows how the effect of the tensile force varies depending as the jaws of the machine are pulling away from each other. The first damage appeared six times in the middle of the sample at the narrowest point and once where the spigot is located.

This testing method proved that concrete can fail under the channel and around the drainage installation. The tests proved that we can prevent concrete breakage under the channel by using various types of anchors and that ACO is able to design drainage to accommodate expansion grooves anywhere on the floor.

Floor-drainage connection types (edge profiles)

- Standard edge connected directly to the floor
- Standard edge with flexible joint

For evaluation purposes, other connection types were also tested including different types of additional edge profiles and installations which lack a groove that's usually present at the floor-drainage connection.

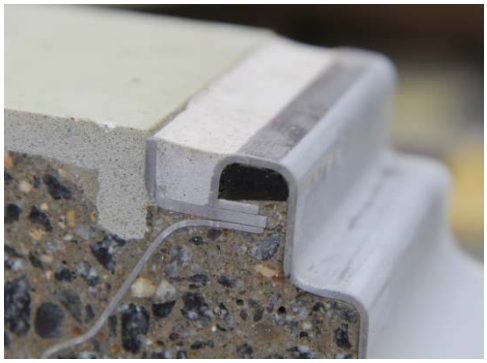


Figure 9 – Detail of a sample edge-floor connection

Floor types

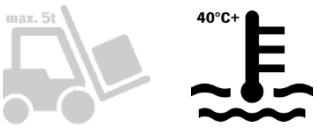
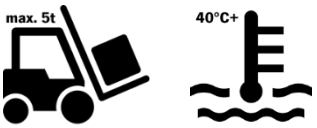
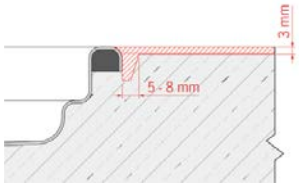
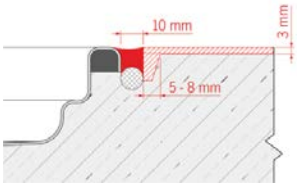
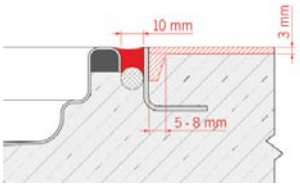
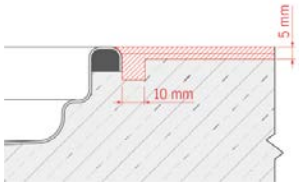
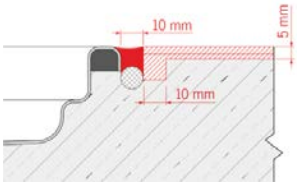
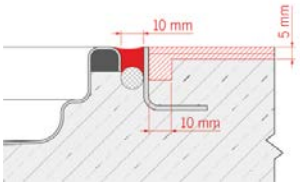
- Polyurethane - Sikafloor-326 + ColorQuartz + SR-169 PUR elastic and self-leveling compound with sand surface - normal to moderate mechanical and chemical stress, wet areas, food and beverage industry
  + Resilience and flexible, mechanical resistance, antiskid properties, easy maintenance
- Hybrid - Sikafloor-21 PurCem cement screed modified polyurethane (hybrid) - resists medium to high loads, abrasion and high chemical loads, is shock resistant and resistance to high temperatures. It is suitable for use in environments exposed to thermal shock such as freezers, cold and wet and dry areas. It has high chemical resistance properties, has a similar performance to concrete which regard to cohesion and strength, and is performs at a higher level with regard to mechanical resistance, cracking and when installed without working joints


Figure 10 – Testing sample

We also subjected the flooring samples to exposure to water for different periods of time and changed the diameter of the testing wheel in the mechanical testing rig to simulate different conditions.

The results

The preliminary test results show promising outcomes with certain types of edge profiles. The research proved to be a valuable experiment that will establish a new way to design floor-drainage connections in respective industries. Choosing the right type of systems with respect to operating conditions and site traffic has always been a challenge and is turning out to be one of the main key topics we review when undertaking a drainage assessment.

Floor type	Resistance to exposure scenarios[1)]		
	Standard edge connected directly to the floor ▪ Resistant to dynamic stress (thermal load < +25°C) ▪ For areas with frequent heavy traffic **Typical applications:** ▪ Warehouse ▪ Corridors 	**Standard edge connected to the floor with flexible joint** ▪ Resilient to temperature extremes caused by alternating hot and cold water **Typical applications:** ▪ Cleaning in place (CIP) ▪ Kitchen 	**L shape edge** ▪ Resistant to both thermal and dynamic shocks **Typical applications:** ▪ Beverage production ▪ Packaging plant ▪ Bottle washing plant 
Sikafloor®-327 *+ ColoredQuartz* *+ Sikafloor®-169*			
Sikafloor®-21 *PurCem®*			

1) The results are according to a floor to drain connection testing carried out by ACO and SIKA

2) Water exposure directly into the channel < +90°C (Max. exposure of the flooring system < +50°C)