CHEMICAL RESISTANCE OF RESIN FLOORING

FeRFA Guidance Note No. 3

MARKET NEED

Resin floors have been used for many decades to provide chemically resistant protective coatings, generally for concrete bases but also for metal or other structures. The need for such chemical resistance is not restricted to the more obvious heavy chemical industries but can apply in a wide variety of situations. The range of aggressive materials may range from cleaning or sterilising preparations, to oils and fuels, to food products or derivatives, to natural or synthetic fats and oils, to highly aggressive acids, alkalis and solvents. The function of the flooring may be to protect the concrete against direct surface erosion or to prevent attack on the reinforcement with consequent loss of structural integrity. Increasingly, chemically resistant floors have an environmental purpose of preventing surface liquids from contaminating the ground beneath the structure.

In either case it is essential, first of all, that the flooring is effectively impermeable, to prevent aggressive agents reaching the concrete below. And then, that the flooring is itself unaffected by repeated or continuous contact with the aggressive agent.

In practice it must be borne in mind when specifying chemically resistant floors that no one product will be resistant to all the possible contaminants likely to be met. Different resin types will be resistant to different classes of chemical and consequently the flooring has to be selected that is appropriate for the specific working conditions. This will require precise definition of what aggressive agents may be present but also how they are dealt with in general housekeeping. For example it is unlikely, simply for reasons of health and safety, that the most aggressive chemicals would be left in contact with the floor for any length of time before they are cleaned off.

CHEMICAL RESISTANCE OF RESIN FLOORING

There are a number of factors that will affect the resistance of a resin based flooring system to attack by chemical agents:

- The resin / polymer basis of the flooring
- The degree of cure of the floor system prior to chemical attack
- The thickness of the flooring
- The type and reactivity of the chemical agent
- The physical properties and concentration of the chemical agent
- Temperature
- Acidity / alkalinity / solvency / compatibility

WHAT IS CHEMICAL ATTACK?

In the broadest terms the attack of a resin floor surface must be considered to be the breaking down of the polymer structure such that it is unable to fulfil its function. This may become evident as erosion of the surface, softening or embrittlement leading to early wear, blistering or delamination. Secondary effects may occur such as the development of a superficial stain, the progressive yellowing of the base resin or the discoloration of a pigment. In some cases visual changes may not be serious if the long term durability of the floor is not affected but will be undesirable if aesthetics are important.

METHOD OF ATTACK

There are a variety of methods of attack of a floor system, including:

Solvent attack: This is primarily a physical process where the solvent is absorbed into the body of the resin binder, giving rise to swelling of the surface and disruption of the bond structure. This disruption leads to a softening of the resin binder, increased wear and loss of film integrity. Each cycle increases the ease with which the solvent is absorbed resulting in surface wrinkling, progressive breakdown of the reason and delamination.

In the early stages of the attack this may appear to be a reversible process, with the coating “drying out”; however the damage is progressive and irreversible. The effect is limited to the area of spillage.

The rate of breakdown will be a function of the type of resin polymer, its density of cross linking, the length of time that the spillage remains on the surface, and the nature of the attacking solvent. (Small molecule materials tend to cause far more damage than larger molecules)

Chemical attack by acid or alkali: Here the attack is primarily chemical in nature and is a result of the breakdown of the resin polymer by chemical reaction, leading to a weakening of the surface. This generally results in increased mechanical damage, loss of surface finish, increased wear and premature failure. This is generally a visible process in terms of the occurrence being localised to the area of the spillage, and is a “ top down“ process with increasing severity as a result of repeated spillage

Chemical attack by reactive organic materials: Materials such as ethanoic acid (acetic acid) can attack by both of the above mechanisms. This can make them highly destructive in certain circumstances: the solvent effect of the organic solution allows the material to soak deep into the surface, the chemical attack opening the material up in depth resulting in rapid failure throughout the resin binder.

RESISTANCE OF THE BINDER TO CHEMICAL ATTACK

Certain resin polymers are more resistant to attack by chemicals than others due to lower reactivity or difficulty of the attacking agent to approach the polymer. There are a number of resin chemical types that can be used for this application, which then cover a wide range of flooring classes. The selection of type is dependent on the nature of the application and the performance requirements of the floor.

In general terms, the higher the resin content and the cross linked density of the system, the better the chemical resistance will be. The incorporation of specifically chemically resistant materials in a system can improve resistance to specific chemicals. It is important that any resin surface that is exposed to chemical attack is correctly mixed, applied and cured under the specified conditions for the period necessary to achieve full chemical cure. The premature exposure of a floor to certain materials may result in the permanent damaging of the floor and long term performance.

LEVEL OF EXPOSURE AND HOUSE KEEPING

It is important to assess the level of exposure of a floor to spillages of chemicals. It should be borne in mind that the very nature of these materials places a duty on employers to ensure that proper house keeping and cleaning are undertaken in the event of a spillage. The presence of solvents can increase the risk of fire: the presence of spillages of acids or alkalis can give rise to burn hazards for staff etc. and can result in damage to plant and machinery.

Where chemical spills can occur it is vital the proper provision is made for the immediate removal of spillage in a safe and effective manner. This should be undertaken by trained operatives using the most appropriate methods for the materials concerned, followed by the cleaning of the surface, and the proper disposal of the waste generated.

It is often not understood that the spillage of a 1 % aqueous solution on a surface can result in the exposure to far higher (30-50 %) concentrations as a result of the material drying out on the surface. The damage that these high concentration effects can cause far exceeds that which would be expected from repeated exposure to the 1 % solution. This in practice means that a surface should be thoroughly cleaned after a spillage and well rinsed to remove any residues, rather than that the surface spillage should just be mopped up.

Similarly the exposure of a surface to a single material at a given concentration may have very different effects if that material is mixed with other materials, this is particularly noticeable where materials are present that encourage the wetting out of the chemical on the surface (surfactants detergents etc.)

CHEMICAL RESISTANCE TESTING

Historically there have been a wide variety of methods used for the testing of protective coatings, similarly there have been a number of ways of interpreting and describing this information. In general terms the methods fall into two groups, standardised methods and company specific methods

When considering the data that these methods generate, care must be taken to ensure that the method is relevant to the application that is being proposed. It should also be remembered that the tests are indicative, that they are undertaken with a specific laboratory grade material on a small test piece of the flooring product made under perfect laboratory conditions.

Methods used have ranged from swab tests where a swab soaked in the test liquid is placed on the surface of a resin flooring sample for a limited period and the effect on the surface assessed visually. At the other end of the scale many manufacturers used variants of an ASTM method in which cast cylinders of the resin flooring (generally 25 mm high x 25 mm diameter) are totally immersed in the test liquid for lengthy periods of time, often several years and the cylinders assessed visually before crushing them to give a quantitative assessment of the chemical resistance. However this latter method is much more severe than likely service conditions except in the case where resin coatings are used as tank linings.

An alternative British Standard test, BS 6319-8 was developed by FeRFA about 20 years ago. Again this involved total immersion in the test liquid, but of a thin beam that was then tested for flexural strength. Many manufacturers were reluctant to adopt this test because of the long term data they had accumulated with the much earlier ASTM test.

The position has now been regularised by the publication of a new European standard test method for determining chemical resistance. This is known as BS EN 13529, 'Resistance to severe chemical attack'. Products that are claimed to comply with the general requirements for flooring products in BS EN 13813 must be tested by the new European method if they are claimed to be chemical resistant. Although described here as the *new* European method it is in fact based on the long standing German OS8 industry standard that had gained wide acceptance in many European countries, although not in the UK.

In this method the Resin flooring is applied to a concrete slab of specified quality. When fully cured, rings of a resistant material are adhered to the surface of the flooring and used to contain the test liquid. The sample is held in controlled conditions to minimise evaporation for the test period and then washed clean, dried and examined visually. Any effect can be quantified by determining the change in the hardness of the surface by the Shore or Buchholz methods as appropriate. The standard has two prescribed test periods: 3 days which could be considered to represent occasional spillage over a period of the life of the floor, and 28 days which is more representative of prolonged immersion or regular spillage of the test materials on the floor.

The standard also has a new feature of specifying particular test fluids that are each claimed to be typical of a family of possible aggressive agents. For example, a 10% solution of ethanoic (acetic) acid is used to predict the resistance to all soluble organic acids, such as are derived from fruits or the souring of milk.

The adoption of a uniform standard by the resin flooring industry will take some time and in most cases fresh data will have to be developed. However in the long term the method should enable the specifier to make better and more reliable comparisons between competing products.

When selecting a coating system to offer chemical resistance, the specifier will normally seek guidance from a supplier or manufacturer for data which details the degree of resistance to attack by a certain chemical or group of chemical products. Loss of gloss, temporary (reversible), softening and staining may occur. In practice you may have a combination of reagents, elevated temperatures and mechanical attrition all acting at the same time to give a more onerous environment than a simple test. To be certain about the performance in service of a resin system where a combination of chemicals exists, it is advisable to make a trial area and gather data from this over a period of time.

CONCLUSIONS

All Resin flooring manufacturers will have built up extensive data banks of chemical resistance tests for their products against a wide variety of possible aggressive chemical agents. This information will enable them to predict how their flooring products might perform in a particular set of circumstances. However except in the simplest cases such predictions should be regarded only as indicative since there are many variables that can affect the severity of the attack. For this reason, reliance on published information provided by the manufacturer of the flooring product should always be backed up by their direct assessment of the potential risk.