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ADVANCES IN FLOORING & SELF-LEVELLING FLOORING

Dr. Fixit Institute
of Structural Protection & Rehabilitation

A Not-for-Profit Knowledge Centre

From the Editor's Desk

India's economic growth rate is the fastest in the world, surpassing China with huge foreign direct investment in manufacturing and infrastructure projects. The thrust being provided to the manufacturing sector is one of the major reasons for the growth rate of the industrial and commercial segments. These two segments have been growing at a rate of 15%-20% in recent times. The size of the industrial and commercial flooring segments in the country is estimated to be around Rs. 4,000 crore and growing. Apart from many industrial townships and industrial corridors, food and beverage industries, logistics, warehousing, and packaging industries have also played vital roles in boosting the industrial flooring market. At the same time airports, metro-rail projects, shopping malls, IT parks, and SEZs, are major infrastructure and commercial projects causing the upward growth of flooring industry in India. Considering the recent developments and new products in flooring, we have dedicated this issue of ReBuild on industrial flooring and particularly on self-levelling flooring for the benefit of our readers.

The areas of industrial floorings and pavements with high performance concrete are abrasion-resistant flooring, ultra-thin white-topping, floor repairs, coloured floorings, and tremix floorings. Considering the types of materials the different types of floorings are decorative epoxy terrazzo, decorative stamped concrete, PU parking deck flooring, Epoxy/PU industrial dust-free flooring, epoxy ESD flooring, steel fiber reinforced concrete (SFRC) flooring, and polymer fortified cementitious self-levelling underlay. New product developments are always in the offing from the top construction chemical companies. This has led to latest innovations like toppings for a wide variety of applications in pharma-clean rooms, ESD (Electrostatic Discharge) floorings, UV resistant coatings, liquid plastics for use in freezing units. Latest polymer technologies help make better underlayment and screeds offering higher chemical resistance and better toughness. Further, the anti-slip and chemical resistance profile suits the individual application. Each system within the range includes a natural thermosetting anti-microbial agent. In all these floorings, the basic materials being used is epoxy, EPU (Epoxy Polyurethane), MCU (moisture cure urethane), PUD (Polyurethane dispersion), acrylic, polysulphide, and polyurea, offering a wide range of flooring solutions. One of the common features in all these flooring is the self-levelling ability of the construction material. It provides a seamless, joint-less, aesthetic, chemical-resistant, hygienic, and dust-free environment.

Self-levelling epoxy flooring has, in fact, become synonymous with high performance and aesthetic flooring in industrial and commercial projects nowadays. Cementitious self-levelling flooring is being used in commercial remodeling/renovation projects to reduce the cost. Epoxy and PU are most commonly used in self-levelling flooring in the industry.

Though self-levelling flooring has been used often in the recent past, the durability is not as satisfactory as claimed. Major defects that occur are de-bonding, bubbling, scratches, uneven surfaces, and so on. Many of the issues related to selection, execution and the aftercare of such self-levelling floorings are nested upon the contractor/manufacturer because of the ignorance of the properties of these materials. All these defects can be avoided if one follows the pre- and post-installation guide-lines. It is also important to give more attention to the surface preparation and follow the step-by-step procedure of mixing, laying, and application of self-levelling flooring during the installation. One of the key factors is the surface moisture content that needs to be checked before installation of the flooring. The detailed guidelines for execution of epoxy/PU flooring have been described in 3rd article of this issue of ReBuild.

Though the acceptance of self-levelling flooring in industrial and commercial segments is very high, in the residential and real-estate markets, the usage of self-levelling flooring is very rare. This is because of the initial cost of the material and absence of any specification for floors and flooring materials. The most common flooring in residential buildings is tile and marble. There are many disadvantages in tile and marble flooring which need to be understood. Tiles and marble flooring needs to be installed by an expert tile layer to ensure thin, even, and neat joints between the tiles. In wet areas, if the joints are opened they become source of leakages. The tile grout must be resealed after certain years or it will begin to look dirty. Worse still, the sealant will create a hazy finish on the tiles if allowed to dry. Vitrified tiles are slippery when wet, which can cause fatal accidents. Vitrified tiles or marbles are not environment friendly. The process of making them causes a significant expenditure of energy and increases carbon dioxide emission. Quarrying and transportation of marble is also not environment friendly. So the time has come to switch over from traditional practices of tile and marble flooring to the more eco-friendly and durable self-levelling flooring.

During the selection process of a flooring material one has to consider the required properties of the flooring based on the area of application, proper material application, and long-term performance as well as the lowest life-cycle cost. Another attractive feature of self-levelling flooring is 3D flooring, which allows the application of decorative images on the floor that can be covered with a glassy polymer layer. The result is a realistic three-dimensional image, adding to the style factor and creating a fantastic decorative effect.

This issue of ReBuild describes all these subjects, along with some interesting case studies on self-levelling epoxy flooring.

Advanced Floor Coatings/ Surfacing

[Excerpts from The Masterbuilder-August 2013, pp.214-218 & March 2014, pp.178-180]

1.0 Introduction

During the last thirty years, the protection of concrete floors has gone from essentially nothing, to a fairly sophisticated process of some type of protective coating or surfacing. The main purpose of course, is to provide protection to the slab from deterioration or contamination, or to provide some added benefit such as aesthetics, wear, non-skid, chemical resistance, and ease of maintenance, physical performance, and a myriad of other properties. We must remember that no other surface in a building/ structure takes more abuse than floors, regardless of the type of building, whether it is domestic, industrial, or commercial.

Floors are subjected to just about every kind of abuse -impact, abrasion, chemical attack, and thermal shock. Concrete floors are not designed to take this continual abuse. Concrete floors are porous and tend to create dust from wear and abuse. They are also subject to abrasion and chemical attack. It's for this reason that all concrete needs some sort of protection regardless of where it's located. The problem, in the overall picture, is to determine that type of protective material to choose for the various conditions.

This article does not concern resilient title, ceramic tile, carpet, or wood, which are placed on top of concrete floors. These do add a benefit, but are primarily used aesthetically for residential and highly commercial areas. This article focuses on coatings that bond directly to the surface and offer long-term protection and may or may not have some aesthetic value.

2.0 Various Types of Flooring Systems

The floorings have various kinds of traditional concrete substrate as surface with floor finishes of mosaic/terrazzo/ tiles/marbles/wood/vinyl etc. However, the advancement in coating materials has led to many advance floor coatings and screedings. A typical flooring system is having substrate like concrete or mortar with primer and two coats of floor coating with top finished coating.

2.1 Epoxy Floor Coating/Screeding

Epoxy floors and epoxy coatings are becoming increasingly popular for use as commercial and industrial flooring. There are a number of different types of epoxy coatings that can be used on floors. Each of these types of epoxy coatings offers distinct advantages when compared to the others.

Epoxy flooring is chemically cured mass of polymer (bisphened-epoxy resin with polyamine polyamides/ cycloaliphatic amines etc.). Epoxy floorings are formulated by various polymers, hardeners, and graded filler. Epoxy coating can lengthen the life of the floor and achieve a great appearance. Epoxy flooring can be applied over many different materials, including steel, concrete, and wood. However, concrete is the best surface for laying epoxy floors. Epoxy floor coating performance is directly affected by surface preparation. The integrity and service life will be reduced significantly if the surface is improperly prepared. A proper surface preparation ensures epoxy coating adhesion to the substrate and prolongs the life of the epoxy coating system.
The constituents of an epoxy flooring is given below:

- Sub grade
- Sub base
- Slip membrane (act as a barrier to rising dampness and moisture, movement in floor slab, polyethylene and polypropylene 1.5 mm thick)
- Floor slab, reinforced, and in reinforced
- Topping layer or Protection

A schematic diagram of epoxy flooring is given in Fig. 1.

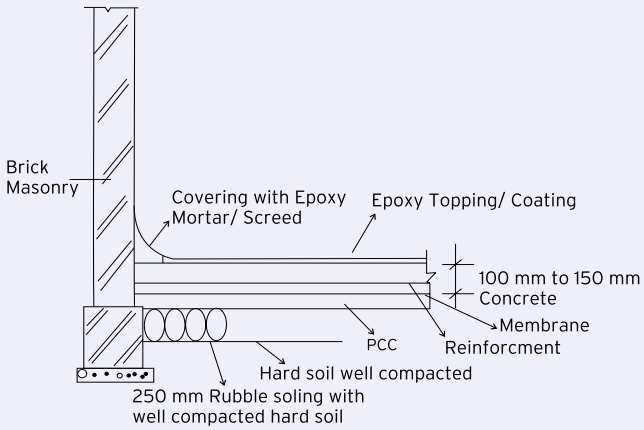


Fig. 1: Schematic diagram of epoxy flooring

The epoxy coatings are ideal for a variety of types of commercial and industrial buildings, including air plane hangars, manufacturing facilities, distribution facilities, warehouses, residential garages, commercial garages, pharmaceutical plants, and laboratories. Epoxy floorings and coatings are ideally suited for a variety of applications. It has a range of anti-skid, antistatic, anti-fungal, anti-bacterial floorings which are formulated to withstand the movement of men and material. Monolithic or specked, dark or light coloured, epoxy floorings are created in one seamless application. The application of epoxy floor plants results in the creation of a hard wearing, durable surface as well as epoxy vapour barrier application to prevent moisture penetration through concrete subfloors. The various properties of the floor coating material are given in Table 1.

Table 1. Properties of floor coating

Property	Standards	Range
Pot life (Min)		2 – 120
Tensile strength (N/mm^2)	DIN EN ISO 527	1 – 60
Elongation at break (%)	DIN EN ISO 527	6 – 100
Modulus of elasticity (N/mm^2)	DIN EN ISO 527	0.1 – 2.5
Compression strength (N/mm^2)	DIN EN ISO 604	≤ 100
Tear propagation strength (N/mm^2)	DIN ISO 34 – 1	1 – 100
Shore hardness	DIN 53 505	A 20 – D 80
Abrasion resistance(mg)	DIN EN ISO 5470-1	5 – 150

2.1.1. Self Dispersing Epoxy Coatings for Floors

This type of epoxy coating is commonly used in areas that receive frequent forklift or heavy truck traffic as it has very good mechanical strength. Another type of this durable epoxy coating is the self-dispersing epoxy with quartz sand. This type of epoxy coating is commonly used in food-processing industries or other locations where liquids are present because it has good anti-slip characteristics.

2.1.2 Self-levelling Epoxy Coatings for Floors

Self-levelling epoxy coatings are easy to install over new and old concrete floors as they level easily creating a seamless and smooth surface. Self-levelling epoxy coatings can be used in kitchens, dining rooms, storage places, garages, warehouses, office buildings, and more (Fig. 2).

Fig. 2: Epoxy flooring in a shop floor

2.1.3 Mortar Epoxy Coatings for Floors

This is the strongest of all epoxy floors. This type of epoxy coating is commonly used in heavy industries application and can also be used to repair cracks before laying other types of epoxy floors.

2.1.4 Gravelled Epoxy Coatings for Floors

Gravelled epoxy coatings are the most decorative epoxy flooring choice, and they can be used for adding logotypes, brand marks, and decorative details to floors.

2.1.5 Epoxy Terrazzo Floor Coatings

This type of epoxy flooring is very decorative (Fig. 3) and easy to clean. Epoxy terrazzo flooring is commonly used in large areas, including hallways and entrances of commercial buildings, schools, and office buildings.

Fig. 3: View of decorative epoxy flooring

2.1.6 Epoxy Antistatic Floor Coatings

This specialized epoxy coating is designed for use where static-sensitive electronic components are in permanent use, and a static-free environment is most important such as in laboratories (Fig. 4), hospitals, and electronics equipments manufacturing plants (Fig. 5).

Fig. 4: Epoxy flooring in a Pharmaceutical laboratory

Fig. 5: Epoxy flooring in an Electrical Panel board room for antistatic properties

2.1.7 Vapour Barrier Epoxy Coatings

Liquid epoxy vapour barriers are applied directly over concrete floors to provide an impenetrable surface that reduces vapour transmission to nearly zero. These epoxy coatings are typically applied prior to adding the final flooring surface, including sheet vinyl, tile, carpet, or hardwood floors.

2.1.8 Epoxy Flaked Floor Coatings

This is not exactly a type of epoxy flooring, but rather a style of applying epoxy coatings. With this epoxy flooring technique, multi-coloured flakes, or chips are added over

the epoxy coating while it is still wet in order to provide a decorative finish or look.

2.1.9 Abrasion Resistant Epoxy Screed Floor

It is a three-component epoxy screed system designed to provide abrasion resistant, impact resistant, and chemical resistant, tough flooring. It is formulated to withstand heavy industrial traffic (Fig. 6) and is available in a variety of colours as well. It should ideally be top coated with transparent, epoxy/polyurethane sealers or with self-levelling epoxy.

Fig. 4: Epoxy flooring in an engineering industry

2.1.10 Self-levelling Epoxy Anti-skid Floor Topping

It is a four component pigmented epoxy floor topping which is laid at a thickness of 1 mm to 2 mm. It is jointless, textured, non-porous, hygienic and chemical resistant, easy to clean, and maintain. It is available in a number of colours and has sufficient strength to withstand industrial traffic with nylon and rubber wheels. It has excellent bonding with concrete and other substrates like Kota stones.

2.2 Polyurethane Floor Coatings

Polyurethane floor coatings have been in commercial use for more than 30 years. They are flexible, hard, and tough coating materials, formulated with polyurethane raw materials for application in many different market segments. Polyurethane coatings can be customized to yield property profiles that suit the individual floors.

As shown in Fig. 7 polyurethane coatings may range from highly elastic (for membranes, floors in sports facilities) to hard and highly resistant to chemicals (for chemical production plants).

Fig. 7: View of polyurethane floor coating at parking in Terminal T2 of Mumbai International Airport

2.2.1 Typical Applications of Polyurethane Coatings

- One and two component primers and sealers.
- Floor coatings for sports facility's membranes, e.g. waterproofing membranes.
- Industrial floor coatings ranging from tough yet flexible to hard depending on the requirements of construction and water protection regulations.
- One and two component synthetic resin mortars and coloured sand mortars.

Instrumental in the success of polyurethane system in these applications are the following properties.

- Curing even at low temperatures.
- Good adhesion.
- Excellent chemical resistance with hard coatings.
- Crack-bridging with elastic and tough yet flexible formulation.
- Seamless application, also with elastic and tough yet flexible membranes.

Hence PU coatings can be designed to have wide range of requirements fulfilling capacities. It features the following:

- Polyurethane floor coating with unsurpassed stain/ chemical resistance
- Excellent abrasion resistance
- High wear resistance
- High gloss to stain finish
- Excellent gloss retention
- Quick turnaround time
- Variety of colours option or select your own custom colour
- UV light resistant polymer coating
- VOC compliance

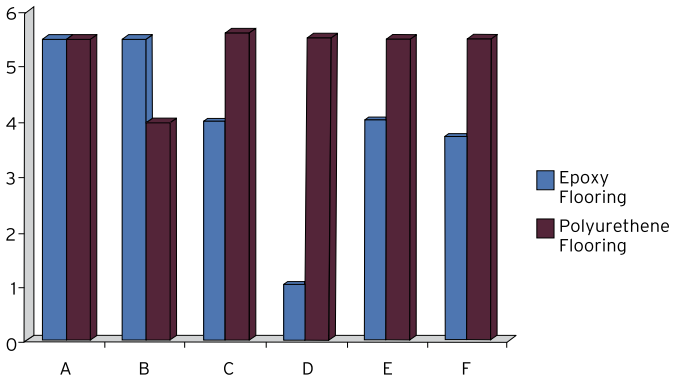
Polyurethane coating is generally recommended for areas exposed to chemicals with a need for cleanability including:

- Aerospace Industries, Hangars
- Automotive Facilities, Auto Service
- Chemical Plants, Clean Rooms
- Furniture Plants, Meat Packers
- Printing Plants, Dock Areas (excellent wear non-slip floor coatings)
- Trenches, Military Facilities

2.2.2 Polyurethane Floor Coating Benefits

Like epoxy, polyurethane is a thermosetting polymer as well and is considered a high-performance coating. Of the different formulations available, aliphatic polyurethane is the desired choice for garage floors, though they are approximately 60% to 70% solids. Depending on the manufacturer, a polyurethane coating is only about 50 to 75 micron in thickness and can't be adjusted as with epoxy. However, the thinner dry film thickness is not all that it appears. Aliphatic polyurethane has more

flexibility than epoxy, and it is this flexibility that aids in absorbing impacts better. It is also far more abrasion resistant, in fact, some manufacturers claim that the wear resistance of polyurethane over epoxy is almost 3 to 1. The resistance to chemicals is better than epoxy as well and includes solvents such as methylene chloride, which is the primary ingredient in paint stripper. A comparison of various properties between epoxy and polyurethane coatings is given in Fig. 8.



A - Chemical resistance B - Compressive strength
C - Antiscratch D - Weathering stability
E - Environment friendly F - Impact resistance

Fig. 8: Comparison of various properties between epoxy and polyurethane coatings

Another advantage of polyurethane over epoxy is that it is UV stable. This means that it won't get yellow like epoxy does when exposed to small amounts of sunlight. The surface of polyurethane is not as hard as epoxy, but it is far more scratch resistant, can tolerate larger temperature swings and handles humidity much better. It is also available in different finishes from satin to very glossy. Though polyurethane has many advantages over epoxy, it does have less bond strength to concrete and its thin dry film thickness will not work well as a self-levelling coating to fill in small cracks in the surface.

2.3 Cementitious Flooring Systems

This is yet another type of flooring system available for floor protection. As the name suggests, one of the binders of flooring product is cement, with one or more than one other resins included into the product. These products are normally more economical comparable to epoxy and PU floor products. Cementitious flooring comes in: A. self-levelling flooring (underlayment and topping) B. screed C. floor repairing product.

Self-levelling underlayment gives smooth, flat surface-ready for floor goods fast. Its level-top can turn a rough, irregular surface into one that is perfect for carpet, wood, ceramic tiles, vinyl virtually any floor covering. Efficient application and fast drying time keep you on schedule. The level top provides a level surface on otherwise out-of-level concrete slabs in apartments, commercial buildings, and homes worldwide.

Cementitious screed is manufactured in single component, or in two components, all products based on cement, fillers, and resins. Under floor hardners, there are dry shake floor hardness in powder form, meant for application in green concrete floor, and liquid form, used for existing concrete floors. Decorative concrete system is yet another type of flooring systems, well famous in advanced countries. In India, now many flooring specialities have stated using the above concept.

3.0 Advantages of Self-levelling Floors

- Attractive appearance: They have beautiful gloss, smooth surface, quite a wide colour range and may be textured, matt or glossy, with decorative effects which expand the original design solutions capabilities.
- Hygienic and easy treatment: Self-levelling floors are often chosen for placements that has high sanitary-hygienic requirements since seamless surfaces are easier to clean and polymer materials themselves are protected from fungi, bacteria and other microorganisms.
- Durability: Right choice of a polymer material and adherence to technologies of floor filling provides for its long service life – up to 40 years, which is considerably larger than the standard service life of any other flooring material.
- Fire safety: Polymer materials used for self-levelling floors are flame retardant and don't release toxic combustion product.
- Resistance to moisture, UV and chemically aggressive environments
- Self-levelling floors don't fade in sunlight, are not damaged by gasoline, oil, acids, alkalis, solvents (the latter can be used to clean highly fouled self-levelling floors).
- High adhesion: Possibility of a good adhesion with various type of base: concrete surface, wooden underfloor, ceramic tile.
- Simplicity of installation: Following the rules of installation, listed by a producer, almost any person can create a self-levelling floor by himself.

The major disadvantages are quite a labour-intensive process of preparation and difficult to un-install.

4.0 Conclusion

The thorough process for selecting a coating or topping system, the writing of a detailed specification and the preparation of detailed application procedures and final acceptance criteria will give the owner a basis for choosing the right system. One has to consider proper material application and long-term performance, thereby reducing the long-term cost of floor maintenance.

Cementitious Self-levelling Flooring

[Excerpts from the Masterbuilder – January 2014 p.p. 192 – 194]

1.0 Introduction

The flooring industry has always placed a strong emphasis on smooth and level concrete surfaces upon which to install resilient flooring. With today's large amount of commercial remodelling/renovation projects, the attempts to reduce costs in the new construction market and the declining availability of competent cement finishers, there is a need of a product that helps to solve most problems related to floor levelling and repair. Fortunately, modern self-levelling cements provide the best solutions that are technically sound and cost effective.

Cementitious self-levelling flooring is polymer-modified cement that has high flow characteristics and, in contrast to traditional concrete, does not require the addition of excessive amounts of water for placement. Self-levelling products (Fig. 1) also called self-levelling concrete, is typically used to create a flat and smooth surface with compressive strength similar to or higher than that of traditional concrete prior to installing interior floor covering. Self-levelling concrete has increased in popularity as the degree of flatness and smoothness required for floor covering products has increased, with vinyl goods getting thinner and floor tiles getting larger.

Fig. 1: View of self-levelling cementitious flooring product

2.0 Areas of Application

Cementitious self-levelling floorings are classified into two main groups of materials: Underlayments and toppings are two main groups of materials. Underlayments are installed over an existing subfloor to smooth it out and correct any surface irregularities prior to the installation of all types of floor coverings, including sheet vinyl, vinyl composition tile (VCT), wood, ceramic tile, and carpet. Toppings perform a similar function but act as the actual finished floor without the need for a floor covering. Some typical applications for concrete toppings include warehouse floors, light industrial applications, retail stores, and institutional facilities. Concrete toppings can also receive pigmented colour dyes, stains, saw cuts, or mechanical polishing to produce a decorative concrete finished wear surface. These floorings can also be coated with advanced coatings based on epoxy, acrylic, and polyurethane resins.

When self-levelling concrete is poured, it has a viscosity similar to pancake batter. A gauge rake is used to move it into place without spreading it too thin. The finishing is then done by lightly breaking the surface tension of the product using a tool called a smoother. The polymers in the self-levelling mix keep the viscosity of the product such that it remains uniform in composition from top to bottom, without the sand aggregates sinking to the bottom of the installed layer. The typical installation thickness of these products ensures there is enough mass present for the material to flow, although some self-levelling products now exist that can be installed at an average thickness of 3 mm to 75 mm for highly undulated subfloors.

Self-levelling means that the mixture of powder and water has a flow viscosity that allows the material to seek its own level before setting. The material can be taken to another place with a gage rake and smoother.

3.0 Advantages

Traditional methods of levelling and repairing concrete floors are both labour intensive and require the use of screeds, trowels, and sanders that are less than desirable because of site mixing, waves, cracks, etc. Self-levelling products have a variety of advantages over trowelable underlayments as follows:

- Application is about eight times faster than trowelable underlayments.
- They do not require the same high degree of expertise as hand towelling.
- They can be used to repair a variety of substrates.
- They are fast setting and can be walked on in a few hours
- Floors can usually be installed the next day.
- They can be installed from a feather edge to several mms in one pour with little to no shrinkage.
- They develop high compressive strength (28 MPa or greater).
- They are water resistant and do not promote the growth of microbial contaminates.

4.0 Application Methodology

4.1 Substrate Preparation

The key to success when installing self-levelling products is to achieve a good bond between the substrate and the self-levelling underlayment. Proper preparation of the concrete surface is the most important factor. The surface must be sound, clean, and free of such residuals as oil, grease, wax, dirt, sealers, curing compounds,

and adhesives. Most self-levelling substrates are shot blasted to ensure that the substrate is clean and free of contaminants. It can be noted that taking a shortcut in substrate preparation is an open invitation to failure.

4.2 Priming

In almost all self-levelling products it is being recommended to use the primer to work as a bonding agent. There are two types of primers used. One is for porous and absorbent substrates, while the other type is used when going over non-porous substrates such as ceramic, quarry, terrazzo, marble, steel, lead, and cutback adhesive residues.

On special types of substrates, an additive may be recommended such as metal substrates and or cutback adhesive residue. The additive will add additional bonding strength and will allow a little bit of deflection into the mix.

4.3 Temperature Control

Temperature control is vital to the success of using self-levellers. With self-levellers, heat is the worst enemy. When dealing with a self-levelling product, one must monitor four temperatures.

- Ambient temperature
- Slab temperature
- Powder temperature
- Mix water temperature

If any of these temperatures exceed 28.0°C it will provide to be detrimental to the application. In warm weather conditions the pour may have to be done early in the morning or late in the evening when temperatures are cooler. Powders can be stored in a cool place and the mix water container can be filled with several blocks of ice to cool the mix water. Heat causes the self-levelling mix to stop flowing prematurely, usually less than the minutes, making it difficult to get it placed on time. In cold conditions the self-leveller will slow its set time down, but beware of any temperatures below 10.0°C, as it will also have an adverse effect on the mix.

4.4. Mixing

When mixing, it is critical to use the correct water-to-powder ratio. Mixing is done by adding the correct amount of powder to a premeasured amount of water. Once the powder is added to the water it is necessary to power mix with a heavy duty drill at about a 650 rpm for approximately two minutes. Power mixing will break the surface tension in the water, allowing for a smooth mix that will flow easily for about six to eight minutes. Once the mixing is complete, the mix should be taken out of the container and on to the floor without delay. The approximate time from the time the powder hits the water to the stop of the flow time is about 10 minutes at room temperature and still some time is needed for the spreading and smoothing process.

4.5 Spreading

Immediately after the mixing process is completed, the mix should be poured onto the floor and moved with a spreader to obtain a uniform thickness. The spreader is a stand-up, handheld device that can be set to apply a desired even thickness of underlayment over the substrate (Fig. 2).

Fig. 2: Spreading self-levelling cementitious flooring product

4.6 Smoothing

The smoother is a second handheld device for the final smoothing by removing the spreader marks, footprints, and all irregularities. The working time varies from eight to ten minutes, depending upon the temperature. While this doesn't seem like much time it is more than adequate to spread and smooth the area. For example, a crew of three can cover about 140 m^2 per hour without any difficulty.

4.7 Pumping

For large installations, self-levelling underlayment can be pumped. The pump will control the critical water-to-powder mixture and allow for a faster installation. For example, a three-man crew can easily do 650 m^2 per hour.

4.8 Drying

The usual drying takes about two hours before you can walk on the newly installed surface, and resilient flooring can be installed the next day. Care must be taken to not allow the underlayment to dry too fast.

5.0 Condition Requirements Prior to Application

It is typically recommended that self levelling cementitious flooring be applied in conditions where ambient temperature is above 10°C, and not more than 28°C. To ensure the integrity of the primer, the moisture vapour transmissions rate (MVTR) from the substrate should not be in excess of 2.2 kg of water/day/93 m^2, based on ASTM F-1869 (Calcium Chlorid test), or 80% RH, based on ASTM F-2170.

6.0 Conclusion

One recent trend in the formulation of self-levelling underlayment is the addition of post consumer recycled aggregates to enhance the materials' contribution to LEED certification and green building. This is most suitable for repair of any damaged floor and where cost economy is required.

Guidelines for Execution of Epoxy / PU Floorings

[Extracted from The Master Builder – January 2012, p.p. 124 – 126 and March 2012, p.p. 152 – 154]

1.0 Introduction

Almost all the industries in India today have epoxy/ PU floorings in their plant area in order to provide a seamless, joint-less aesthetic, chemical-resistant, hygienic, and dust-free atmosphere. An overall survey indicates that not all users are happy with the result. Many of the users express that they experience a variety of problems such as de-bonding, bubbling, scratches, uneven surfaces, and so on and also express a concern regarding its durability. This article aims to address many of these issues related to the selection, execution, and aftercare of epoxy/PU floorings, so as to minimize these instances but not eliminate them completely.

A survey in the USA on epoxy/PU floorings has indicated that about 20% of the problems were due to the wrong selection of material/thickness, 60% due to the wrong application and 20% due to the poor quality of the products. Hence it is important to divide the discussion into three parts:

- Pre-installation guide-lines and checks
- Installation procedures
- Post-installation practices

2.0 Pre-installation guidelines

2.1 Selection of Right Product

Various authors have deliberated on which kind of material to choose for which applications. This is therefore not covered here. The major difference between epoxy and PU systems is that PU is more flexible and hence is more suitable in high-impact areas.

2.2 Selection of right thickness

It is very important to arrive at the correct thickness of flooring to provide optimum service to the required traffic conditions. Higher the thickness, higher the durability and higher will be the cost. Hence, it is pertinent to calculate the right thickness.

2.3 Analysis of the requirement

This is the most important part of the process for the selection of right product as well as the right application methods. Obviously, a single product cannot meet all the requirements and hence the customer has to allot a priority for each requirement. Light duty flooring can be laid from 500 microns to 1 mm, medium duty at 1 mm to 2 mm and heavy duty varies from 3 mm to 6 mm. All the above parameters can be said to resist the following four broad categories:

- Mechanical effects : Static and dynamic loads, abrasion, impact, vibration, skidding, conductive, or antistatic etc.
- Chemical effects : Oil, grease, chemicals, soluble salts, cleaning agents, solvents
- Environmental effects : Thermal exposure such as heat or cold, UV, and other weather conditions, noise
- Biological effects : Bacterial impact

3.0 Pre-installation checks

3.1 Check List

This is a key step in ensuring that the final floor meets or exceeds the expectations of the customer. The following needs to be checked:

- The type of floor – Mosaic / Concrete / Tile / Stones / Marble (if so, check the level of polish).
- Any floor-hardener, curing agent etc. has been used if concrete is present.
- Soundness of the floor with a hammer or scratching the surface with coin etc.
- Porosity of the concrete by putting a few drops of water and check for beading etc.
- Level-difference/undulations on the floor
- Oil spillage, grease, or any other contaminants
- Moisture content preferably under plant operating conditions
- Ingress of water through roof/wall cracks and floor joints
- Any chemical/solvent spillage and its concentration, temperature etc.
- Any possibility of steam impingement
- Type of traffic envisaged and the condition of material handling equipment (type of wheel etc.)
- Understand the customer's expectations
- Estimate the job correctly by preferably measuring the area.
- Surface condition, presence, and location of cracks
- Joints and its locations, types of joints, condition of joints.
- Concrete strength
- Contamination of floor
- Moisture level/movement
- Presence of vapour/moisture barrier
- Types of abuses present
- Usage floor
- Requirement/purpose of laying epoxy toppings/screeds
- Types of industry (pharma, hospitals, engg, chemical, etc.)

3.2 Moisture Testing

Moisture in the concrete or rising moisture from subsoil has been the single most contributing factor for failure due to bubbles. Moisture doesn't just mean water droplets, it could include high humidity. Some coatings shouldn't be applied when humidity levels are high. More obvious sources of serious moisture are things like rising moisture through concrete pores, higher moisture content in a new concrete, standing water puddles on a concrete slab, or, even more likely, a damp or even saturated surface.

- Surface dry doesn't mean really dry. Surface moisture content can be measured by means of a handheld moisture meter (Fig. 1) and the thumb rule is that the moisture content should be less than 5% to allow impermeable coatings to be laid. However, surface moisture is only an indicative test and is not sufficient to test rising moisture.
- There can be (and often is) a high moisture content hidden just below the surface. The standard test is to tape a 1.2 m by 1.2 m plastic sheet to the concrete and see if visible moisture collects under the plastic. Some of the modern epoxies can be applied to wet or damp surfaces but generally a moisture rich surface means no possibility of coating.

Fig. 1: Moisture meter check of flooring

3.3. Check for Oil/Grease

Generally coatings do not stick to greasy, oily, waxy surfaces. This includes many kinds of plastic surfaces. Oily surfaces can be tricky, just grinding the surface is often not good enough, as oil within the concrete is bound to rise to the surface before the primer has the chance to stick. Even on what seems like a non-greasy surface, any coatings will 'bead-up' leaving behind hollow, coating-less circles or voids.

3.4 Check for Dust, Salts etc.

This is one of the neglected steps and can lead to disastrous consequences. Coatings may stick to the dust but not to the base floor and can lead to de-bonding. Salts and/or minerals either deposited out on the surface from the curing of fresh concrete or from the evaporation of seawater on concrete, or steel can quickly ruin a coating.

All the above pre-installation steps are very important activities that should not be ignored to ensure a long lasting epoxy/flooring solution.

4.0 Installation procedures

Once it has been established that the base floor is capable of receiving epoxy/PU topping the installation sequence is to be set in motion. The installation procedure is broadly classified into three important steps:

- Surface preparation
- Application of primer and underlay
- Application of topping

4.1 Surface Preparation

This is the single most important step that determines the life of the flooring. Any slack in this step will adversely affect the quality and durability of the flooring.

The purpose of the surface preparation is to:

- Create a surface profile so as to create a mechanical key which increases adhesion strength
- Create a clean and dry base and remove loose particles
- Improve the penetration of primer
- Removal of oil, grease, and other contaminants that will impede bonding
- Remember the word "DCS": Dry, clean, and sound surface

Some of the questions that need to be answered before commencing the surface preparation are the following:

What is the basic surface on which epoxy/PU topping needs to be applied?

- Vacuum de-watered concrete (power-trowelled)
- Manually trowelled PCC
- Cotta stone/Shabbat stone/Granite/Kadappa/Marble
- Ceramic tile/vitrified tile

What is the status of the base floor?

- Clean or oil soaked
- Existence of cracks, powdery surface etc.
- Soundness of the base floor and porosity etc.

What is the thickness of the topping proposed as the surface profile to be created is directly proportional to the thickness of the coating?

The answers to the above questions will lead you to the following decisions:

- Proper equipment to be used
- Floor grinding equipment
- Mechanical scarification
- Shot-blasting equipment
- Acid etching
- Extent of surface profile required
- Abrasion resistance (Fig. 2)
- Thermal surface preparation (Fig. 3)

The thermal surface preparation is required for following

- Recommended for oil soaked floors
- Application involves burning of oil through special torch by flame.
- Primer application should take place in hot condition only for better penetration.

Fig. 2: Checking abrasion resistance of epoxy flooring

Fig. 3: Thermal surface preparation for epoxy flooring

4.2 Priming

After the surface preparation, the second step is to ensure that the surface is primed properly. The application of priming is as important as that of surface preparation in ensuring the longevity of flooring and is most likely to be ignored by most of the contractors. As may already be known, concrete consists of micro-pores that typically do not allow penetration of filler-rich epoxy coatings. Hence, it is essential that the initial bonding is achieved by an epoxy primer that contains only resin and hardener and is of such viscosity so as to penetrate the pores of concrete thus creating a bond equivalent to that of spiked shoe on a soft floor. Thus, the concrete pores that are opened up by surface preparation get filled by a proper epoxy primer and increase the durability of the topping multi-fold.

Depending on the porosity of the concrete, viscosity of the primer shall be properly chosen. The normally available epoxy primers will not agree with vitrified tiles, polished marble/ granite etc., these call for specially formulated primers.

Once the primer layer is cured, which typically can take 4 to 12 h, depending on temperature and humidity, screed underlay has to be applied. It is strongly advised that screed underlay is applied over primer not later than 24 h. Once the primer layer is hardened, the inter-phase bond between screed and primer can diminish. In case of delay in screed application, it is advisable to wipe the primed surface with solvents like Xylene, MIBK etc.

When the total thickness of the floor topping exceeds 3 mm, it is preferable to do a 2 mm self-levelling screed underlay followed by 1 mm self-levelling topping instead of 3 mm topping together. Though this concept is being questioned by many, the argument in favour of doing a screed underlay has the following merits:

- The function of screed underlay is to provide a strong base with excellent compressive strength and bond-strength, while the function of topping is to provide abrasion resistance, chemical resistance, aesthetics etc. Thus, it is prudent to formulate two different products to optimize the properties.
- Levelling of undulated floors is much easier.
- In essence, it can also reduce the overall price of the system.

4.3 Topping

Execution of topping is very similar to that of execution of self-levelling underlay except the fact that topping contains a forth component i.e. pigment. Pigment needs to be added to component A (resin part); mixed well and component B & C are to be added sequentially.

Proper mixing machines need to be used to ensure homogeneity of the system and consequent development of desired properties. Do not allow mechanical movement for 48 h and chemical exposure for 7 days.

5.0 Post-installation practices

Some do's and dont's

- Clean the floor regularly with a mop at least once a day.
- Do not allow any loose sharp particles to be strewn on the floor and ensure to remove the same immediately.
- Check the wheels of the vehicles regularly to ensure that there are no sharp particles adhering on the wheels.
- Rectify the leaking pipes and joints immediately (e.g. Oil carrying pipes in machines).
- Avoid dragging heavy loads like machinery, wooden crates etc.
- Periodically inspect the areas and rectify damaged areas immediately.
- Do not clean epoxy floors with acid.

6.0 Conclusion

Epoxy / PU floorings have been found to give an excellent service in various industries such as pharmaceuticals, food, automobile/auto ancillaries, textile, electronic, and electrical industries, light engineering, chemical industries, etc. However, it is important to ensure that the execution and maintenance has been done as per various standard procedures and hope that this article helps in an in-depth understanding of the same.

Self-levelling Epoxy Flooring – Case Studies

[Excerpts from Dr. Fixit Case Studies]

1.0 Case study-1

HSM floor of Bhusan Steel Plant at Angul, Odisha was laid with self-levelling epoxy flooring from the Dr. Fixit range of products. The surface was rubbed and grinded to a level and smooth surface (Figs. 1-2). The first coat was with high adhesion epoxy primer of Dr. Fixit Pidipoxy EP, the second coat was with a strong epoxy under lay of Dr. Fixit Pidipoxy Under lay and finished coating was with self-levelling epoxy flooring of 1 mm thick with Dr. Fixit Pidipoxy ESL 1000. The total thickness of the flooring system was 3 mm. The work was carried out with a local applicator in the year 2010. The step by step process of mixing and application of primer, underlay and finished coat are shown in Figs. 3-10.

Fig. 1: Inspection of condition of floor

Fig. 2: Floor grinding

Fig. 3: Mixing of two component primer Dr. Fixit Pidipoxy EP

Fig. 4: Application of Dr. Fixit Pidipoxy EP primer

Fig. 5: Mixing of Dr. Fixit Pidipoxy Underlay-SL

Fig. 6: Application of Dr. Fixit Pidipoxy Underlay-SL

Fig. 7: Application of Dr. Fixit Pidipoxy Underlay-SL

Fig. 8: Mixing of Dr. Fixit Pidipoxy ESL 1000

Fig. 9: Application of finished coat with Dr. Fixit Pidipoxy ESL 1000

Fig. 10: View of self levelling epoxy industrial flooring after installation

2.0 Case study-2

The floor surface of workshop of comprehensive vehicle unit of EME Shilllong, Meghalaya (Fig. 11) had many cracks, oil spillage and deteriorated concrete floor at their repair bay, tool stores, spare stores and machine room (Figs. 12-13). The existing concrete floor was needed to be replaced with seamless, tough and an aesthetic look floor finished modern flooring. Epoxy self-levelling flooring from Dr. Fixit was used to replace the existing concrete floor and flooring was successfully completed, thereafter same specification was recommended for flooring in all their workshops of EME.

Fig. 11: Comprehensive vehicle unit of EME Shilllong

Fig. 12: Cracks in existing floor

The unit repair bay, Tools and stores, Spares Stores and machine rooms were applied with Dr. Fixit Pidiseal 43 for treating concrete joints (Fig. 14), Dr. Fixit Pidipoxy EP as primer, Dr. Fixit Pidipoxy ESL 1000 Epoxy flooring system as finished coat and Dr. Fixit Pidipoxy EC SF for boarders and drawers.

Fig. 13: Debonding of floor surfaces due to wear and tear

Fig. 14: Sealing moving joints for floor with Dr. Fixit Pidiseal 43

The total surface area of the flooring was 900 m^2 and the work was carried out by enlisted contactor in year 2009.

The step by step application from surface preparation to installation of the coating is given in Figs. 15 to 20. The before and after images of self -levelling flooring floor installation of Hoovers spares-blast proof machine room, TSS Confidential room & Workshop Master Bay room are shown in Figs. 21 to 26 respectively.

Fig. 15: Scraping of concrete surface and exposing weak floor concrete substrate

Fig. 16: Priming of floor surface

Fig. 17: Mixing of primer Dr. Fixit Pidipoxy EP

Fig. 18: Application of Dr. Fixit Pidipoxy EP

Fig. 19: Mixing of Dr. Fixit Pidipoxy ESL 1000

Fig. 20: Mechanical Mixing in a container

Fig. 21: Floor of Hoovers spares-blast proof machine room before

Fig. 22: Floor of Hoovers spares-blast proof machine room after self levelling flooring

Fig. 23: Floor of TSS Confidential room before

Fig. 24: Floor of TSS Confidential room after self levelling flooring

Fig. 25: Workshop Master Bay Before

Fig. 26: Workshop Master Bay after self levelling flooring

3.3 Case study-3

Interim test range missile (ITR), Chandipur, Balasore, Odisha of DRDO had laid the antistatic epoxy flooring of Dr. Fixit Antistatic SL. A test was carried out to check the antistatic property of the product after the installation in an area of 140 m^2 in their Tech area of MES in year 2010.

3.3.1 Principle of testing

The electrical resistance of a laid floor covering is measured on the surface between two electrodes. The basic difference between conducting and antistatic flooring is electrical resistivity between these two types of flooring. The resistance of floor surface to earth must be less than 50 x 10^3 Ω in case of conducting floor and should between 50 x 10^3 to 2 x 10^6 Ω in case of antistatic floor when measured with a wet electrode. A warning notice should be displayed on buildings in which anti-static precautions are necessary.

3.3.2 Surface Preparation

The surface of the floor should be cleaned and dried. The application of fullers earth followed by wiping with distilled water is suitable method of cleaning. The same method was was used for the cleaning the surface before the testing.

Preparation of test pieces: The test is carried out at the site after 48 h of laying antistatic flooring.

3.3.3 Equipment required for the test

Tripod Electrode: It is comprising of a triangular aluminium plate with an insulating layer on the upper surface and three cylindrical feet of conductive rubber on the underside at a distance of 180 mm apart. The rubber feet should have a hardness in accordance with ISO 48 of 50 to 70 IRHD (International Rubber Hardness Degrees) and the electrical resistance of each rubber foot should be less than 10^3 Ω when tested between two metals.

Resistance meter: It should be calibrated to determine the resistance R of the floor covering to an accuracy of ± 5% in the range of 10^3 Ω to 10^{10} Ω and an accuracy of ± 10% greater than 10^{10} Ω. For resistance less than 10^6 Ω it should be 500 volts D.C. The resistance meter used in this test is shown in Fig. 27.

Fig. 27: Resistance meter

3.3.4 Testing procedure

Two cleaned tripod electrodes were placed, separated by a distance of 100 mm, on the surface of the dry floor covering. Each of the electrodes was pressed to apply a load of minimum 300 N on the floor covering. This was achieved by using a person's body weight standing on foot on each electrode as shown in Fig. 28.

Fig. 28: Checking antistatic property of self-levelling epoxy flooring

The resistance was measured by a Digital Megger after 10 s to 15 s of switching on of the equipment. The procedure was repeated 15 times after shifting the tripod electrodes. The testing was carried out as per standard procedures given in EN 1081 and test results were found out to be within ranges and the anti-static property of the same flooring could be checked and verified.

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Venue : DFI-SPR, Mumbai

Participants : Engineers of Indian Oil (IOCL) from all over India

Topic : Certificate Course on Entrepreneurship in Waterproofing, Structural Protection & Repair of Concrete Structures

Date : 3 – 14 August 2015

Venue : DFI-SPR, Mumbai

Topic : Advancements in Construction Chemicals for Durable Structures

Date : 20 – 21 August 2015

Venue : Dr. Fixit Knowledge Centre, Kochi

Corporate Training Progarmme

Topic : Advancements in Construction Chemicals for Durable Structures

Date : 3 – 4 September 2015

Venue : K. Hemani Group Builders at Lokhandwala Complex, Kandivali (E)

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2	10 & 11 Mar 2016	DFI – SPR, Andheri (E), Mumbai	Building Maintenance – Waterproofing and General Repairs	₹ 4600	• Manifestation of weathering distresses in concrete buildings • Diagnosis and condition assessment • Advanced Waterproofing Materials, Systems and Application Methodologies • Strategic planning and maintenance of buildings

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Mr. T. P. Banerjee delivered technical session on "Waterproofing and Repair Materials" in the Seminar on "Retrofitting and Rehabilitation of Buildings" organised by Indian Building Congress, Delhi on 17th July 2015.

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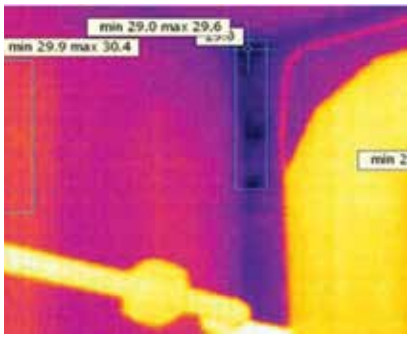

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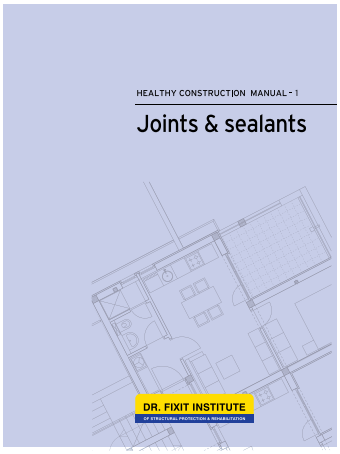

ISBN 978-81-909802-0-3,

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The Manual on "Joints and Sealants" covers different types of joints and their need in concrete structures. It explains the movement of joints and how to design such joints at different locations consisting of different materials both for cast-in-situ as well as precast constructions. It also provides solutions to seal those joints with different types of sealants. The manual provides guidelines for selection of materials for structures with fluid pressure and industrial floor joints and how to install those sealants including use of water stops / waterbar. The environment, health and safety aspects are also covered.

HEALTHY CONSTRUCTION MANUAL - 2

Protective Coatings

(For Concrete & Masonry Surfaces)

ISBN 978-81-909802-1-0,

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The Manual on "Protective Coatings for Concrete and Masonry Surfaces" is aimed to guide the practising and maintenance engineers in selecting suitable protective coating for durability of concrete and masonry structures. It also provides details on method of application, standards and specifications for executing the jobs at site. The various topics covered: Introduction, Properties and Test Methods, Characteristics Performances of different Coatings, Application, Quality Assurance, Safety, Health & Environment and Preparation of Tender documents including Appendixes, List of Relevant standards, equipment and their function.

For purchase of above Manuals, please send your Demand Draft / Cheque in favour of "Dr. Fixit Institute of Structural Protection & Rehabilitation" at the address given overleaf or contact Ms. Clotilda Dsouza on Tel.:022-28357188, Mob.: 09594420601

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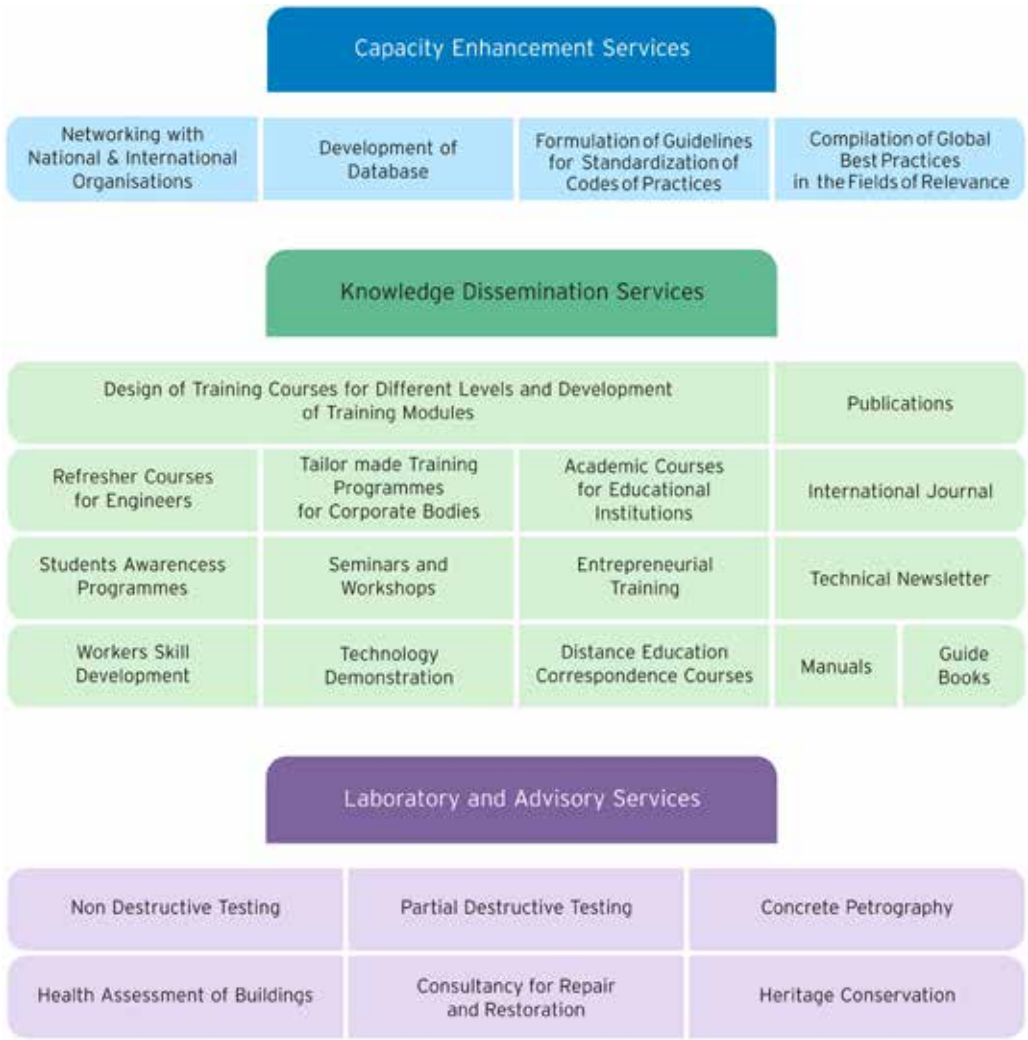

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