Concrete - An Economic Finishing Material

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Abstract: The paper discuss and proposes different concrete floor finish for “build your own home-youth project”, as an economic cost effective approach. It outlines the basic composition of unenforced concrete slabs for flooring. Coating, staining, stencil, and engraved decorations are discussed. The applications of concrete finished flooring both indoors and outdoors are proposed. Examples of applications are included. These include driveways, stairs and steps, entrance, corridor, room, kitchen, balcony and terrace, patios, and swimming pool decks. Different designs are outlined for specific applications.

Key words: Concrete, Flooring, Indoor, Outdoor, Countertop, Stairs, Steps, Driveways, Patio, Entrance, Corridor, Kitchen, Bathroom

INTRODUCTION

The ministry of housing proposed allocating housing land for youth at economic prices to meet their limited incomes. The management plan conditionally contracted the beneficiaries to build their own town houses in limited time. This was known as “build your own home” project. The lack of funding plans makes it difficult to many of them to meet the contracted time. Their limited resources could not meet the cost of construction of luxury or even moderate houses. The finishing of such town houses usually cost 60 to 70% of the total house cost. This is simply because of the limited height of the house, which considerably reduce the foundation cost and the cost of the concrete structure for such limited heights. It was therefore thought that concrete finishes indoor and outdoor for floors, walls and some decorative utilities would reduce the construction cost and make life easier in realizing their dreams (Edgar., 2008).

Concrete is a mixture of Portland cement, water, aggregates, and in some cases, admixtures. The cement and water form a paste that hardens and bonds the aggregates together. Concrete is often looked upon as “man made rock”. Concrete is a versatile construction material, adaptable to a wide variety of residential uses. Concrete has strength, durability, versatility, and economy. It can be placed or molded into virtually any shape and reproduce any surface texture (Suprenant., 2007). Concrete is the most widely used construction material in the world. In Egypt, almost twice as much concrete is used as all other construction materials combined.

With proper materials and techniques, concrete can withstand many acids, silage, milk, manure, fertilizers, water, fire, and abrasion (Ratliff., 2007). Concrete can be finished to produce surfaces ranging from glass-smooth to coarsely textured, and it can be colored with pigments or painted (True, 2004). Since concrete is a structural material, strength is a desirable property. Compressive strengths of concrete generally range from 1500 to 3750 Newton per square cm, but concrete can be made to withstand over 7500 N/cm2 for special jobs (Bayne., 2007). Concrete consists of mixtures of Portland cement, Aggregate such as sand, gravel, crushed rock, and Water. Admixtures are added when necessary. The strength and other properties of concrete are highly dependent on the amount of water and the water-cement ratio. Aggregates occupy 60 to 80 percent of the volume of concrete. Sand, gravel and crushed stone are the primary aggregates used. All aggregates must be essentially free of silt and/or organic matter.

The goal usually is to determine the most economical and practical combination of readily available materials. Furthermore, to produce a concrete that will meet requirements under specific conditions of use (Horton., 2007). With the understanding of these goals, one can make properly proportioned concrete mix, which provide: Workability of freshly mixed concrete, Durability, strength, uniform appearance of hardened concrete, and finally economy. Workability is the property that determines the ease with which freshly mixed concrete can be placed and finished without segregation. Workability is difficult to measure; therefore, it is important to accurately describe what the concrete is to be used for, and how it will be placed (Lstiburek., 2008). Durability, wear resistance, and strength depend on the cement mixture. A mixture with a sufficiently low ratio of water to cement plus entrained air, if specified, is the most desirable. These properties--and thus the desired concrete quality--can only be fully achieved through proper placement and finishing, followed by prompt and effective curing.

Quality depends on the amount of cement and the water-cement ratio (Anon., 1989). Proportioning should minimize the amount of cement required without sacrificing quality. One should hold the water content to a minimum to reduce the cement requirement. Minimizing cement and water requirements means using the
stiffest practical mixture, with the largest practical maximum size of aggregate and the optimum ratio of fine-to-coarse aggregates. The minimum cement content for a specific strength requirement assures desirable concrete properties, such as workability, durability, and finish ability (Henderson., 2008). The minimum amount of cement is required in order to adequately coat all aggregate particles and provide proper bonding. The maximum aggregate size should be no larger than one-third the thickness of the concrete.

When delaminations form in floors, thin layers of the surface break away from the base concrete (Barrett., 2009). Delaminating is featured as elongated voids, 1 mm below and parallel to the finished surface. Several factors contribute to the problem. These include working the surface with vibration or improper floating, low relative humidity, high wind velocity, rising air temperature, exposure to direct sunlight, dry shakes, out of flatness, and incorrect burnishing. Thick slabs, improper cement mixture, high sand content, and high water content are also physical factors.

Concrete is also considered the shop floor of the industry; the floor is the most important part of the building (Little., 2006; Ringo and Boyd, 1988). All activities occur on or near the floor and the remainder of the structure is simply a means of protecting the floor and workforce from the environment. It is commonly used for factory shop floor, and can be equally decorated and coloured.

**Concrete Floor Finishes:**

Concrete finishes enhances the integrity of architect's designs. They are easy to maintain (Eddy., 2007; Walton., 2007). It is easy to change, especially if one sells his home; the next owner can place carpet or wood on top of the concrete slab. They are great in regions with a lot of sand or snow. They are a good alternative to carpet if you have allergies. It has become the new material of choice for designers and homeowners across the world. Concrete floors in stained, colored, painted, and personalized glory are popping up in retail stores, trendy restaurants, offices, and homes everywhere (Nasvik., 2008). A concrete floor offers numerous options for interior rooms including nearly limitless designs, colors, and even health benefits. With decorative concrete, there is also no risk of chemical emissions, like there are from new carpeting. These emissions can be especially hazardous in basement spaces that are not well ventilated. Unlike carpets, which are a breeding ground for dust mites and other allergens, concrete, is easy to clean and be maintained mite free. It costs less than tile, it is easy to maintain and care for, there is so much versatility with all the color, pattern, and border choices, and anyone can have a floor that is one-of-a-kind. Finally it avoid radioactive emissions which radiates from granite tiles (New coatings for concrete., 2008). Concrete serves nicely for both indoor and outdoor applications (Pickard., 2008).

**INDOOR**

**Porches (Balcony And Terrace):**

Balcony and terrace are basic features of the apartments in Egypt. Many people would care for having such open areas as an open air space, where they can set outdoor away from the limited indoor stagnant space. Figure 1 shows typical concrete floor finish for balcony and terrace. These were poured in position and the surface was leveled before.

![Concrete floor finish for balcony and terrace areas](image)

**Fig. 1:** Illustrate concrete floor finish for balcony and terrace areas

Stamping the free surface with the required pattern, texture and color. 10 cm thick concrete slab was produced and a mould was internally stained with natural colors as required before pressing it against the surface with loads high enough to make the mould penetrate the surface layer to a pre-specified depth, which
generates the effect of unit boundaries. Further coatings with polyamides ensure the glazed appearance of the surface.

Porches (Entries):
Stencils offer nearly unlimited options for taking concrete interior floors over the top (Stenzel., 2005). Stencils sheets are placed on the free surface of well-leveled concrete slab, and sprayed with colored paints, which is left to dry before an epoxy layer was uniformly laid as a glazed top layer. Figure 2 shows how these stencils can be made to simulate real designs of carpets within entrance area. Figure 3 however shows how such designs can be further simplified for larger areas, such as reception, to simulate the pattern of large carpets or ceramics flooring.

Fig. 2: Stencil printed carpet images for entrance.

Fig. 3: Stenciled frame on stained plane concrete within the reception area
Corridor:
Corridors can be decorated by engraving the boarders of stencil image on the stained concrete. A stencil image is first projected on the corridor stained concrete flooring the boundary lines are engraved with a sharp tool. Further staining with contrasting colors is made according to the required design. Finally epoxy polished and wax layers are laid down on top to protect the surface and maintain the shining glazed surface. Figure 4 shows two designs, one with stained image and the other with plane polish surface treatment.

Room Flooring:
Each concrete slab can accept the stain in varying degrees of intensity, creating natural color variations that bring character and distinction to each project. What acid stains do not offer is a broad color selection. These are mostly in a limited array of subtle earth tones, such as tans, browns, terra cottas, and soft blue-greens tones.

However, newer materials such as water-based penetrating stains and water- and solvent-based concrete dyes are greatly expanding the artist's palette with colors ranging from soft pastels to vivid reds, oranges, yellows, and purples. Both scoring and saw cutting can be used for decorative effects and for the necessary work of being the control joints in the concrete surface. Decorative effects only need to be 5 mm deep. Concrete stain does more than simply add color. Rather than produce a solid, opaque effect like paint or colored coatings (Pickard., 2008), stains permeate the concrete to infuse it with rich, deep, translucent tones. Depending on the color and application techniques used, the results can mimic everything from polished marble to tanned leather to natural stone or even stained wood. Figures 4 & 5 shows examples of produced surfaces and patterns.

Fig. 4: Engraving of both stencil images and plane polish finish concrete

Fig. 5: Tile engraving, and stencil printing against mirror polished coated room floor
Although stain is permanent and will not flake off like paint, it penetrates only the top layer of the concrete surface and will eventually wear away as the surface is worn by traffic or weather exposure. To prolong stain life, stain manufacturers recommend keeping stained surfaces protected with multiple coats of clear sealer (outdoors) and a floor wax (indoors). A good sealer will provide other benefits as well, such as adding shin to the surface and enhancing color intensity (Nasvik, 2008). These are shown in figure 6.

Fig. 6: Marble effect versus stone effect room flooring

**Kitchen Flooring:**
Kitchens usually need resistive coatings against corrosion and chemical reactions. Flat smooth polished surface are necessary to avoid contamination and maintain hygiene.

Wear and corrosion resistant coatings are deposited on mirror polished stained plane or imaged surfaces to enhance the surface resistance to kitchen contaminants as shown in figure 7.

Fig. 7: Tile effect on plane-polished mirror like surfaces for kitchen floor

**Patios:**
Patios are meant to create functional use of space which may vary from one design to the other. Therefore one can not cover the too many designs of such areas, however figure 8 shows how most of these patterns and colors were employed in two examples of patios.
Outdoor:

Stamped concrete, commonly referred to as patterned concrete or imprinted concrete, is concrete that is designed to resemble brick, slate, flagstone, stone, tile and even wood. This paper shows how stamped concrete can be used to beautify pool decks, driveways, entries and courtyards, and patios. Due to the wide array of concrete patterns and concrete colors, and the cost of stamped concrete in relation to the materials it is a substitute for, the choice of stamped concrete is becoming more popular and frequent.

Concrete provides the perfect canvas for creating an economical replica of more expensive materials, and yet still maintaining a very natural, authentic look.

Driveways:

Drive ways are constructed either in front of the home town as shown in figure 9, or along lanes between two rows of town houses as demonstrated in figure 10. Stamped concrete can be the most appropriate for such application. Colors and patterns for stamped cement are often chosen to blend with other stone, tile or patterned concrete elements at the residence. Complex designs incorporating steps, courtyards, and fountains can be achieved when patterns are pressed into the concrete. Stamped concrete can also be blended with other decorative concrete elements such as exposed aggregate finishes and acid-etch staining, along with a particular pattern, such as running bond brick, hexagonal tile, worn rock or stone. This process can be done on driveways, walkways, sidewalks, and front entries.

Fig. 8: Patios are stamped or engraved according to the functional use of the space.

Fig. 9: Drive way of regular stone stamping on concrete in front of town houses

Fig. 10: Long drive ways between rows of town houses
Stairs and Steps:
Outdoor Stairs and steps are essential to make up for differences in ground levels to save on land leveling. Specially designed outdoor stairs and steps are shown in figures 11 & 12.

Fig. 11: Outdoor stairs and steps to make up for different ground levels

Fig. 12: Concrete Outdoor stairs and steps in marble effect and brick laying designs

Swimming Pool Decks:
The techniques described earlier for driveways, walkways, sidewalks, and front entries, can be applied for pool decks, patios, garages, and interior floors. Stamped concrete, surface textures, spray deck need special tools and equipment to etch patterns and designs into existing concrete.

One of the biggest trends in outdoor design today is a decorative concrete pool deck, a colored, textured and inviting area surrounding the pool that does more than provide a safe, slip-resistant deck for sunbathing and barbecuing. Concrete pool decks are now given nearly as much attention as the interior design of the home. Figure 13 shows non-slip marble tile effect design engraved on the swimming pool deck.

Fig. 13: Non-slip marble tile effects are engraved on the swimming pool deck

When the concrete is further enhanced by staining, the decorative possibilities are truly spectacular. The benefits of concrete are many. It can provide an extremely durable surface, as compared to a wooden deck or even stone. With the new techniques for stamping and applying decorative concrete, any look can be created at a
fraction of the cost. Figure 14 shows stamped rock and stone effect designs, whilst figure 15 shows how engraving and carving can add beauty to the swimming pool deck.

Fig. 14: Stamped rock and stone effects on the swimming pool deck

Fig. 15: Engraving and carving of patterns on the swimming pool deck

Concrete Engraving briefly is staining the concrete to give it color, then engraving (routing) out a pattern. The routed area is now uncolored- thus it looks like a grout line. Unlike toppings or overlays, engraving is a permanent treatment that will not wear away or lose bond because the patterns are carved into the concrete rather than applied on top of it. Complicated stencil images can be engraved as shown in figure 16. It can be used to define limit frames and border lines as shown in figure 17. It is also equally applicable to irregular boundaries as shown in figure 18.

Fig. 16: Some Complicated stencil images can be engraved to be permanent

Fig. 17: Some Stencil images can be used to decorate limit and border frames
Fig. 18: Combinations of stencil and engraved images with irregular boundaries

Stenciling can be a great alternative to decorative stamping while permitting similar design flexibility. Sometimes referred to as cement pool decks, the choices available for designing a truly unique, functional, and affordable pool deck are now at fingertips. The most popular methods for coloring exterior concrete are chemical stains, integral color and dry-shake hardeners. Each of these methods can be used alone or one can combine or "layer" them to create unique multi-tonal effects.

Colors and patterns for stamped concrete can be chosen to blend with other landscaping elements around your home. Stamped concrete can also be intermingled with other decorative concrete treatments, such as exposed aggregate finishes and chemical staining.

Decorative concrete has opened the doors to creating pool decks that complement the exterior of the home, meld with the outdoor environment, and replicate exotic and traditionally expensive materials such as slate, stone or even wood.

Coloring concrete is one of the best ways to beautify a pool deck, give it more distinction, and make the deck blend in with its surroundings. Coloring usually goes hand in hand with stamped or stenciled concrete, allowing you to precisely replicate the colors of natural stone or any other material. Figure 19 shows how simple coloring techniques were used to achieve such beautifying style.

Fig. 19: Coloring of concrete for beautifying the pool deck

**Interior Work:**

**Concrete Countertops:**

Concrete countertops are so popular (Biddle and Daniel, 1991; Myatt, et al., 2009). Their versatility can work for economic designs. Color options are unlimited or abound. One can create a functional and beautiful workspace in the smallest of kitchens. However, if there is room, the ability to custom and create the kitchen is amazing. In fact, Concrete countertops are of warm natural looking material that corresponds with the popularity of more natural materials like wood, stone, and brick. Staining concrete is one of the most popular applications for transforming concrete slabs. Often referred to as colored concrete, homeowners, designers and builders are advised to deal with stained concrete because of the unique outcome that can be achieved combining colors, application techniques, etc., on cement flooring and other substrates. The results are limited only by the creativity of those involved in the stained concrete process.

Avoid abrasive soaps or cleansers. Concrete works recommends a mild, non-abrasive, non-ammoniated soap for daily cleaning. They suggest Simple Green (dilute as suggested) or natural soap (5 parts water, one part soap.) Others recommend a neutral pH cleanser and warm water. They note to avoid using abrasive pads.
Concrete comes into its own. Concrete is not a static material. If you seek a surface that will not evolve or acquire character over time, choose another material. Handmade and tactile, it is influenced by its interaction with the craftsman and eventual user. For the many people who love concrete, the unpredictability is part of its attraction. Veining, texture and color vary, and regular use affects a warm patina to the surface over time.

Cast concrete countertops have become the favorite of designers and architects because concrete can give warmth and color depth not available in granite marble or Corian. Hand finishing gives the counters a finish as smooth as glass with a patina that improves over the years. Figure 20 shows countertops made of fiber reinforced concrete, whilst figure 21 shows complete kitchen units (top and frame) in matching wood effect colors. Figure 22 however shows stainless steel sink mounted within matching concrete countertops.

**Fig. 20:** Kitchen Countertops made of fiber reinforced concrete to maintain level when supported at the edges

**Fig. 21:** Complete kitchen units (Countertops and supporting frame) in matching colors with the wood doors and drawers

**Fig. 22:** Kitchen stainless steel sinks mounted within matching concrete countertops

**Fig. 23:** Examples of bathroom washing sink designs
**Bathroom Sinks:**

Bathroom sinks are no different. It can be constructed on concrete frames fitted with wood painted doors and drawers. Short tops may not need reinforcement, but long ones need fiber reinforcement to take the tensile stresses due to edge support. Figure 23 shows how this is implemented in bathroom sink designs.

**Dinning Tables:**

Dinning tables can be casted onsite together with the supporting frame figure 24. It can be shaped to fit the space and allow for time and motion study. The drawback of course is the permanent orientation and positioning. Fiber reinforced tops are certainly recommended.

![Fig. 24: Special dinning table design to fit the space and the standing openings](image)

**Fire place:**

The fireplace and fireplace surround serve as the centerpiece of a room, both visually and socially. A beautiful fireplace and fireplace surround provide an eye-catching focal point. If properly designed, the fireplace and fireplace surround can serve as a worthy substitute for any work of art. Figure 25 shows different design for concrete built-in fireplaces. Coatings may not be suitable in such use as the fire will cause discoloring.

![Fig. 25: Concrete built-in fireplaces](image)

**Conclusions:**

Concrete floor offers numerous options and enhances architects designs including nearly limitless design patterns, colors, and even health benefits. Concrete flooring can be used indoor as well as outdoor, and can be easily changed. Furthermore, it can be used for numerous interior facilities and built in units. The following points are concluded:

1. The cost of concrete floor finish is far more economic and can replace more expensive materials.
2. Time taken for creating concrete floor finish is far less than traditional flooring.
3. Concrete is the most widely used construction material in the world, with proper materials and finishing techniques it withstand many acids, water, fire and abrasion.
4. Concrete can be finished to produce surfaces ranging from glass-smooth to coarsely textured, and it can be colored with pigments or painted.
5. Concrete is a versatile construction material, adaptable to a wide variety of residential uses and is easy to maintain.
6. Concrete has strength, durability, versatility, and economy.
7. It can be placed or molded into virtually any shape and reproduce any texture.
8. Stencils offer nearly unlimited options for taking concrete interior floors over the top.
9. Each concrete slab can accept the stain in varying degrees of intensity, creating natural color variations that bring character and distinction to each project.
10. Newer materials such as water-based penetrating stains and water- and solvent-based concrete dyes are greatly expanding the artist's palette with colors.
11. Both scoring and saw cutting can be used for decorative effects and for the necessary work of being the control joints in the concrete surface.
12. Concrete stain does more than simply add color. Rather than produce a solid, opaque effect like paint or colored coatings, stains permeate the concrete to infuse it with rich, deep, translucent tones. Depending on the color and application techniques used, the results can mimic everything from polished marble to tanned leather to natural stone or even stained wood.
13. Multiple coats of clear sealer (outdoors) and a floor wax (indoors) keep stained surfaces protected and life is prolonged. A good sealer will provide other benefits as well, such as adding shine to the surface and enhancing color intensity.

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