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Case study on Alternative concrete finishing for a cost effective and faster building construction process in Ethiopia

A case study submitted to the school of graduate studies of Jimma University

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DECLARATION

This case study is my original work and has not been presented for a degree in any other university.

Submitted by	Signature	Date

This case study has been submitted for examination with my approval as university supervisor.

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Co-Advisor	Signature	Date
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Abstract

Every country has its own traditions regarding construction methods. These traditions are dependent upon features such as available local construction materials, the local climate, geotechnical conditions, etc. They also rely upon economic and political circumstances of society. In order to improve the construction methods, it is first important to be aware of the construction methods currently being used, and the problems and advantages that these construction methods imply.

The different types of concrete finishing methods on residential and commercial building construction currently employed in Ethiopia both by local and foreign contractors are discussed and the evaluation of these methods are made cost wise. It is important to understand the difference between cheap or low-cost and cost-effective construction. It is possible to produce buildings to a low-cost at the expense of decreased quality and design. Conversely, by the use of cost-effective building construction systems buildings are produced to a low cost while maintaining a high standard of design and comfort.

This paper has indicated comparison and selection criteria for cost-effective and faster methods of concrete finishes that will give increased construction efficiency by approaching the effectiveness of each alternative currently used from the point of view of the entire building process. The matters discussed here gives understanding of the strengths and weaknesses in each concrete finishing method and by that it is possible to pick the best alternative for a specific project.

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CHAPTER ONE

1. INTRODUCTION

1.1 Project Background

Time and cost have been typically used as key criteria for examining project performance in the construction industry. There are many possible ways in which the cost of construction can be reduced without reducing the quality of work. One way of lowering the cost is to develop building construction methods that will give increased construction efficiency.

Concrete is the most common building material used in today's construction industry. It can be cast in any desired shape and fashion and is therefore applicable for most building purposes. Its long life and relatively low maintenance requirements has made it popular. Concrete does not rot, rust or decay and is resistant to wind, water, rodents and insects. It is a non-combustible material, making it fire resistant and able to withstand high temperatures. Due to its remarkably good properties very few complaints are received compared to the applicability of concrete in the construction industry. While it is easy to determine the properties of the hardened concrete that will be suitable for the intended purpose, great care is required throughout the entire construction process to ensure that the hardened concrete actually has the desired properties.

One reason for the continued increase in concrete use is that architects and developers are discovering that concrete is ideal for far more than walls and floors. with the help of an ever-growing selection of concrete finishing products and with the right combination of skill and knowledge, concrete can be textured, colored and patterned.

1.2 Statement of the problem

Most of the residential and commercial buildings being constructed currently are reinforced concrete structures. No matter how this construction projects vary in size and complexity most of them follow similar methods and procedure of construction. Due to the presence of construction works everywhere and these similarities in the methods of construction reinforced concrete construction has become a traditional construction method where no specifications and quality control methods are employed both in design and construction respectively.

Almost all the construction works handled by the local contractors follow the same procedures i.e.

1. Sub structure,
2. Supper structure or the skeleton,
3. Masonry works,
4. Service works and
5. Finally finishing works

In most projects the finishing works being thought to be the remedial works which is going to take place at the end of the curing period. The concrete works at different stages of construction are not made with the required qualities while formwork selection and construction, concrete mixing placing and curing periods. An enormous amount of money and time could be saved by doing the concrete works to the required standard while casting on the first place.

On constructions in Ethiopia handled by local contractors finishing works on top of concrete frame structures are the common finishing methods provided. These finishes which use additional material, labor and construction time should be compared with other finishing methods that use the concrete surface itself as a final finish.

1.3 Research Questions

- What are the causes of common concrete surface defects and how can we prevent or correct these defects?
- What are the alternative methods of cast insitu concrete surface finishes?
- What are the advantages and disadvantages of the different types of cast insitu concrete surface finishes?
- How do we compare the finishing on top of concrete vs Fair Faced Concrete on the basis of construction cost and time?

1.4 Project Objectives

1.4.1 General objective

The general objective of the research is to identify the variables for selection of construction cost and time efficient concrete finish alternatives.

1.4.2 Specific objectives

- ✓ Understanding the cause, prevention and repair of common concrete surface defects
- ✓ Review of alternative means of surfaces finishes on cast-insitu concrete
- ✓ Understanding the pros and cons of each surfaces finishes on cast-insitu concrete
- ✓ Construction cost and time comparison of the use of additional finishing materials vs using the concrete itself as a finishing material

1.5 Scope and limitation

This independent project is limited in scope to the following:

1. In this paper, the time and cost effects of concrete finishing works on building construction in Ethiopia are re-examined.
2. Focus on residential and commercial building construction projects

The limitations and possibilities of existing technologies are used as basis for time and cost comparison of the construction methods Here, it is important to clarify that it is not possible to

find the absolute best way of constructing since there are too many variables involved. This cannot, therefore, be set as the final goal for this work, but more as a compass direction.

1.6 significance of the study

Using the prevention measures to avoid the different types of concrete surface defects the construction time could be shortened and use of additional material and labor wasted for remedial and additional finishing works could be avoided.

Understanding of the alternative concrete finishing work and the time and cost effects of each provide professionals and clients clear basis for the selection of cost and time efficient concrete finish.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Introduction

Finishing is the operation of creating a concrete surface to the desired texture smoothness and durability for functional, protective or decorative purpose.

Reduced construction time at the building-site and waste of materials and resources contribute to further reduction of the costs.

2.2 concrete Surface Defects: Causes, Prevention & Repair

The most common defects on the surface of a concrete that are caused while finishing concrete need additional finishing works could be blisters, cracking, crazing, delamination, discoloration, dusting. These deficiencies, caused by specific factors that are explained in the following paragraphs, can be minimized or prevented by adhering to proper construction methods.

Blisters

Blisters are bumps that may range in size from 5mm to 100mm in diameter with a depth of about 3mm which appear when bubbles of entrapped air or water rising through the plastic concrete get trapped under an already sealed, airtight surface.

Causes Blisters could be

- An excess amount of entrapped air held within the concrete by a high percentage of material passing the No. 30, 50, and 100 sieves, resulting in a sticky or tacky concrete that can become more easily sealed when floating or finishing it at any early age.
- Insufficient vibration during compaction that does not adequately release entrapped air; or overuse of vibration that leaves the surface with excessive fines, inviting crusting and early finishing.
- Finishing when the concrete is still spongy.

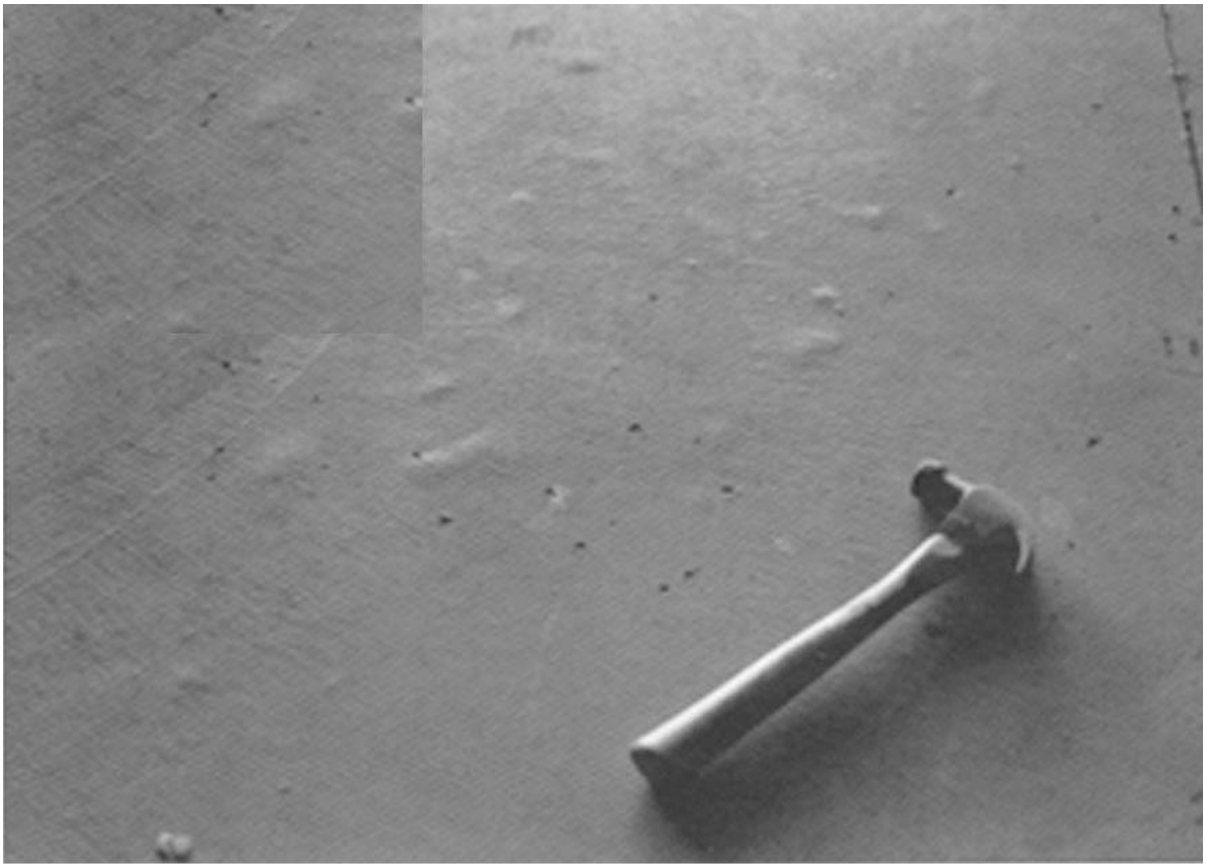

Figure 1 Void trapped under a blister.

To avoid blisters, the following should be considered:

- Do not use concrete with a high slump, excessively high air content, or excess fines.
- Use appropriate cement contents
- Warm the subgrade before placing concrete on it during cold weather.
- Avoid placing a slab directly on polyethylene film or other vapor barriers.
- Avoid overworking the concrete, especially with vibrating screeds, jitterbugs, or bullfloats.
- Do not attempt to seal (finish) the surface too soon. concrete.
- Use proper finishing techniques and proper timing during and between finishing operations.
- Reduce evaporation over the slab by using a fog spray or slab cover.
- Avoid using air contents over 3% for interior slabs.

Cracking

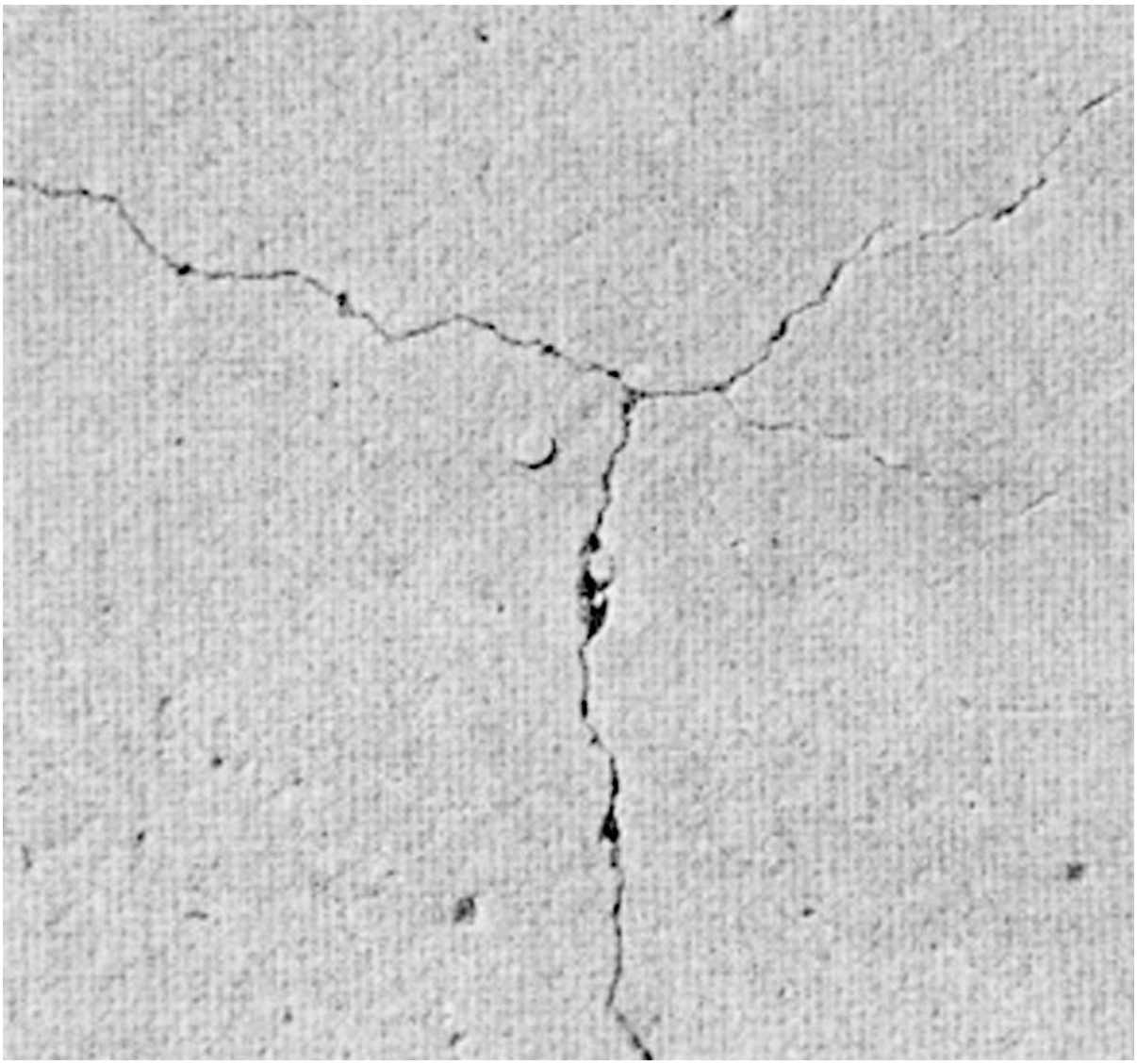

Figure 2 Drying-shrinkage cracks

Unexpected cracking of concrete is a frequent cause of complaints. Cracking can be the result of one or a combination of factors, such as drying shrinkage, thermal contraction, restraint (external or internal) to shortening, subgrade settlement, and applied loads. Cracking can be significantly reduced when the causes are taken into account and preventative steps are utilized. (Taylor, Peter C., Detwiler, Rachel J., and Tang, Fulvio J ,2000)

Cracking in concrete can be reduced significantly or eliminated by observing the following practices:

- Use proper subgrade preparation, including uniform support and proper subbase material at adequate moisture content.
- Minimize the mix water content by maximizing the size and amount of coarse aggregate and use low-shrinkage aggregate.
- Use the lowest amount of mix water required for workability; do not permit overly wet consistencies.
- Avoid calcium chloride admixtures.
- Prevent rapid loss of surface moisture while the concrete is still plastic through use of spray-applied finishing aids or plastic sheets to avoid plastic-shrinkage cracks.
- Provide contraction joints at reasonable intervals, 30 times the slab thickness.
- Provide isolation joints to prevent restraint from adjoining elements of a structure.
- Prevent extreme changes in temperature.
- To minimize cracking on top of vapor barriers, use a 100-mmthick (4-in.) layer of slightly damp, compactible, drainable fill choked off with fine-grade material. If concrete must be placed directly on polyethylene sheet or other vapor barriers, placed directly on polyethylene sheet or other vapor barriers, use a mix with a low water content.
- Properly place, consolidate, finish, and cure the concrete.
- Avoid using excessive amounts of cementitious materials.
- Consider using a shrinkage-reducing admixture to reduce drying shrinkage, which may reduce shrinkage cracking.
- Consider using synthetic fibers to help control plastic shrinkage cracks.

Crazing

Crazing, a network pattern of fine cracks that do not penetrate much below the surface, is caused by minor surface shrinkage Crazing cracks are very fine and barely visible except when the concrete is drying after the surface has been wet. The cracks encompass small concrete areas less than 50 mm (2 in.) in dimension, forming a chicken-wire pattern. The term "map cracking" is often used to refer to cracks that are similar to crazing cracks only more visible and surrounding larger areas of concrete.

Figure 3 Crazing, a network of fine surface cracks.

The climatic conditions, particularly the relative humidity during the drying period in a wetting and drying cycle, are an important cause of crazing when concrete is just beginning to gain strength. Low humidity, high air temperature, hot sun, or drying wind, either separately or in any combination, can cause rapid surface drying that encourages crazing.

To prevent crazing, curing procedures should begin early, within minutes after final finishing when weather conditions warrant. When the temperature is high and the sun is out, some method of curing with water should be used, since this will stop rapid drying and lower the surface

temperature. The concrete should be protected against rapid changes in temperature and moisture wherever feasible.

Delamination

Delaminations are similar to blisters in that delaminated areas of surface mortar result from bleed water and bleed air being trapped below the prematurely closed (densified) mortar surface.

The primary cause is finishing the surface before bleeding has occurred. Delaminations are also more likely to occur when factors that extend the bleeding time of concrete (e.g. cold substrate) are combined with factors that accelerate surface setting (e.g. high ambient air temperature).

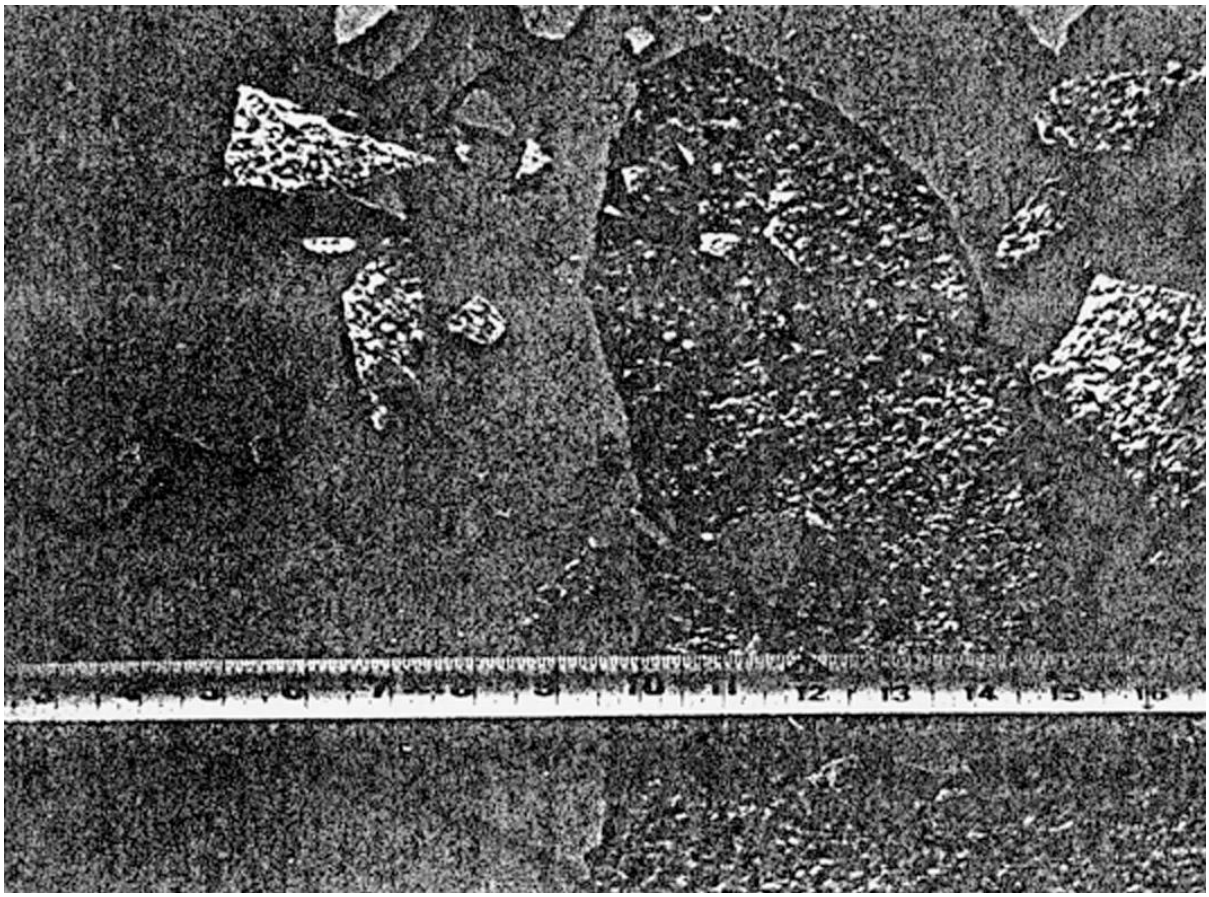

Figure 4 Delamination as a result of sealing the surface before bleeding

Delaminations also may be the result of disruptive stresses from chloride-induced corrosion of steel reinforcement or of poorly bonded areas in two-course construction. The resulting delaminations are deeper than those caused by trapped air or bleed water and are often called spalls.

Some good site practices that may reduce the likelihood of delamination occurring include; Correct timing of the final trowel finishing

- Uniform placement, consistent bleed rate and consistent setting time of concrete
- Use of air-entraining and set retarding admixtures should only be used where specifically required (eg where long travel time to deliver concrete is required)
- Properly prepare the sub-base to provide a uniform laying platform including dampening the sub-grade and where plastic membrane is being used ensuring the membrane is free from tears and is properly lapped to prevent uneven loss of moisture.
- Properly and uniformly compact the concrete
- Properly and rigidly fix reinforcing ensuring appropriate cover
- Uniformly place, compact and finish the concrete.
- Attempt to ensure that climatic effects on the concrete such as wind, temperature and humidity are consistent over the entire concrete surface
- On the first pass of the troweling machine the blades should be as flat as possible, finishing blades can be tilted at progressively greater angles to gradually increase the compaction of the surface layer
- Use a walk behind power floating machine for the first pass to aid surface levelling before subsequent passes using ride on machines.

Delaminations can be repaired by patching or, if widespread, by grinding and overlaying with a new surface. Epoxy injection may also be beneficial in some applications.

Dusting

Dusting is used to describe the situation where the surface of the concrete becomes non-durable and a fine powder of concrete is continually deposited on the surface.

The causes of dusting include the addition of excess water on site and premature finishing of the surface.

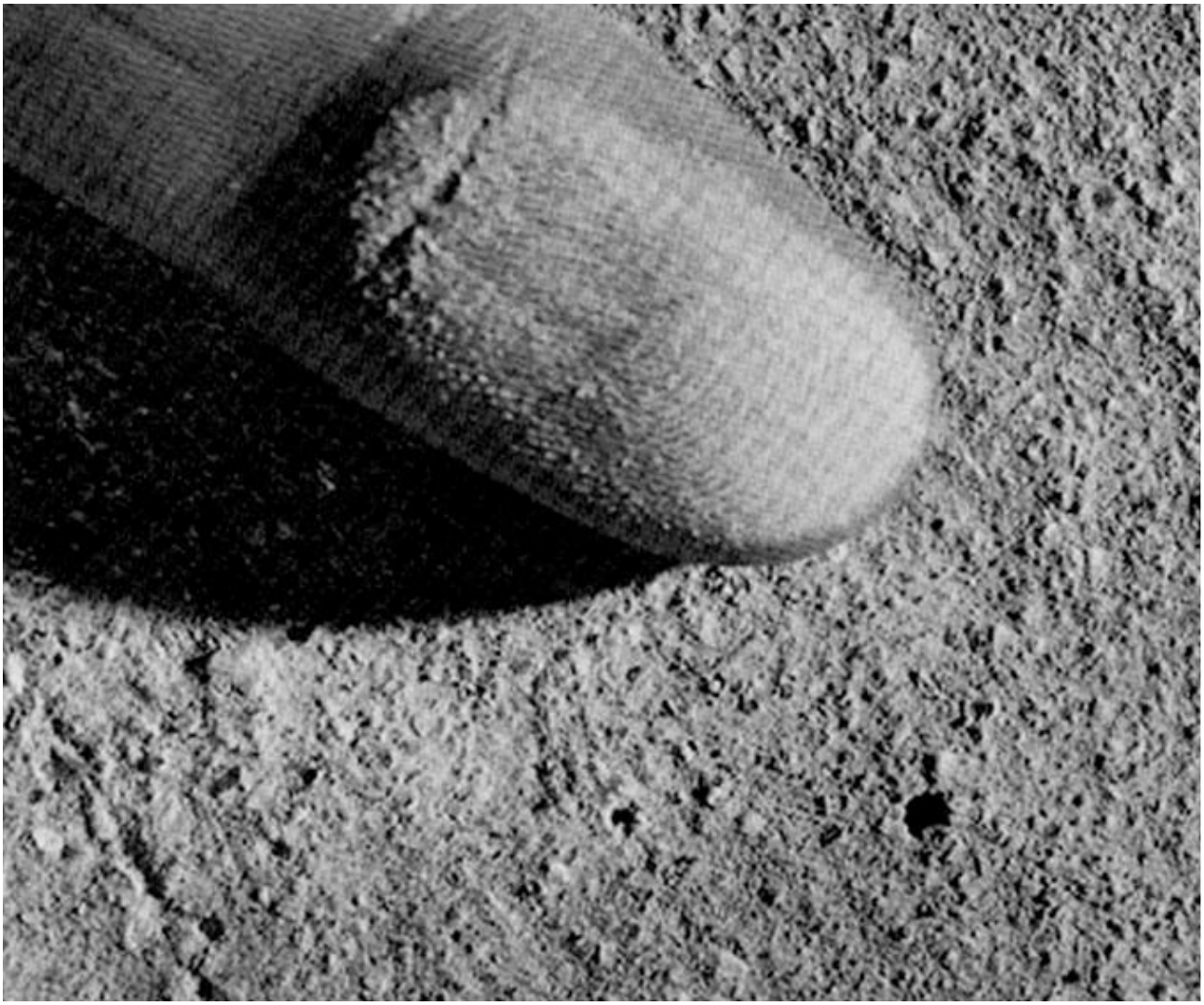

Figure 5 Dusting evident by the fine powder that can be easily rubbed off the surface

Good site practices that reduce the likelihood of dusting occurring include;

- Avoid adding additional water to the mix on site
- Take care to avoid the likelihood of rainwater increasing the water to cement ratio of the surface concrete either by increasing the volume of water in the concrete or by washing the cement powder out of the concrete.
- Correct timing of the final trowel finishing and in particular avoiding premature finishing
- Avoid overworking the concrete
- Properly cure the concrete
- Specify the correct concrete strength for its intended purpose

2.3 alternative concrete Finishing methods

2.3.1 Off-form Concrete Finishes

This category covers the concrete surfaces that are primarily dependent on the formwork for texture and finish. As such the most effective results are gained by attention to detail before the concrete is cast. The formwork dimensions, rigidity, joint tightness and texture all become of increasing importance Often short-cuts prove very troublesome and costly in the long-term with significantly more hours, and money, being spent attempting to remedy defects resulting from such short cuts (Cement Concrete & Aggregates Australia.2006).

The creation of off-form concrete finish is influenced by the:

- Form lining and formwork system
- concrete mix including type of cement and aggregates
- added pigments
- selection of a suitable release agent
- subsequent surface treatment such as washing, sanding, polishing and sand-blasting

Formwork

The type of formwork, its condition, construction, care and maintenance will all impact on the quality of the off-form finish. Apart from selecting the appropriate formwork material and/or system, some other items to consider regarding formwork and its impact on the off-form concrete surface include:

Formwork must be adequately supported to avoid excessive deflections during placement of concrete. If tall vertical elements are placed in a single lift, the lateral pressure on the formwork will necessitate additional tie rods or braces to avoid deflections in the finish.

The location of joints between formwork sheets may have a considerable impact on the appearance of the off-form concrete finish. The joint shown in Figure 74 some 300 mm above a construction joint in the column detracts from the appearance of the element, and could be unacceptable if the appearance of the surface was critical. Formwork should have been continuous from the

construction joint to the soffit of the beam. (Cement Concrete & Aggregates Australia ,2006) Formwork should be constructed with tight joints and no gaps at corners or edges to prevent grout loss during placement – which may stain the finished work

Care must be exercised when removing formwork to avoid damage to the off-form concrete surface. The use of appropriate form release agents and detailing will facilitate this.

Concrete mix

Ingredients and the concrete mix design should be kept consistent throughout the project. Because color is sensitive to water content, the total water content should be kept the same for each batch of concrete. Excess water should not be added on site. Also, if pigments are used for coloring concrete, the specified quantity of pigment must be added to the concrete batch and mixed thoroughly. If pigments are added on site, the quantities for each batch must be the same.

Concrete should be thoroughly mixed when it arrives on site. Inadequate mixing may lead to colour variations. As each type of transit mixer may vary in the time taken to adequately mix the concrete, the time required for thorough mixing should be fixed.

Concrete strength should be maintained. Changing the strength by adding more cementitious material or reducing the water content will affect the color.

Minimum total water content. When concrete is compacted, any water that cannot be held within the spaces between the aggregate and cement particles will bleed to the surface. If excessive bleeding occurs along the form face, scouring or streaks may result. If bleed water in vertical elements is trapped in the setting concrete at the top, hydration staining may result. Where color control has been specified, the use of low-bleed mixes is particularly important.

placing

The concrete should be placed at a continuous rate and consistently for each section of the work. In walls, the placing rate should be such that the lateral pressure assumed in the formwork design is not exceeded. If concrete for vertical elements is placed full height, the increased lateral pressures exerted by the fluid concrete may cause deflections in both individual formwork

components and the overall formwork system which exceed allowable limits. Even if deflections do not exceed these limits, they can still detract from the off-form finish by creating shadows over the surface under particular lighting conditions. While all formwork will deflect under pressure, if achieving a relatively 'flat' finish is critical to the project, then tighter tolerances on formwork deflection may be required. Also, the settlement in each layer should be substantially complete before the next layer is placed, taking care to avoid the formation of cold joints. This minimizes bleeding into the layer above and consequent changes to the water-cement ratio, and hence color.

Placement should occur in uniform horizontal layers, care being taken that the concrete is not moved horizontally or made to flow by the use of vibration. Placing in layers may result color variation between the batches of concrete.

When placing by pumping, the lines are usually first coated with a cement slurry to reduce the friction and drying of the concrete mix as it is pumped through the line. Sometimes a small quantity of diesel (oil) may be used. It is important not to allow this material to be placed onto/into the forms as it may coat the formwork, or mix with the concrete

Compaction

Proper compaction is especially important for high quality off-form finishes as it ensures that the formwork is completely filled (no pockets of honeycombing), that blowholes are minimized and that sand streaks are not formed. Compacting concrete using immersion vibrators firstly sets the aggregate particles in motion, reducing the internal friction and causing the concrete to slump and fill the form. With further vibration, the entrapped air is expelled from the concrete. Vibration must be continued until air bubbles no longer appear on the surface, otherwise areas of honeycombed concrete and particularly blowholes in the off-form finish may result. (Cement Concrete & Aggregates Australia ,2006)

Thorough compaction of the top section of vertical elements such as columns and walls is particularly important. Fewer blowholes usually occur in the lower half of vertical elements because the weight of the fluid concrete above provides additional compaction to the lower part of the element. Without the weight of concrete to assist compaction of the top section, a greater number of blowholes may occur to minimize the formation of blowholes in the top section, the top

half meter of walls and columns should be rodded and/or revibrated prior to the concrete stiffening. Special care should be taken to avoid touching the form face with immersion vibrators during compaction as any damage to the form face will be reflected in the off-form finish Sand streaks may also be formed in the surface of the concrete due to the incorrect withdrawal of the vibrator.

Curing

With off-form concrete surfaces where colour control has been specified, some special precautions are required to ensure the finish is not stained or discoloured during the curing process. If the formwork is kept in place to cure the concrete it is best to leave it in close contact with the concrete, thereby preventing air movements which may cause the surface to dry out. Even slight gaps between the form face and concrete can result in non-uniform curing conditions and hence colour variations.

Thus formwork must remain in close contact with the concrete and be stripped after the same period of time for each element. (Taylor, Peter C., Detwiler, Rachel J., and Tang, Fulvio J ,2000) When planning large projects, concrete placement should be scheduled so that this is possible. Placement should, for example, be scheduled so that stripping is not required when labour is unavailable, say on a weekend. Once formwork is removed, any subsequent curing methods should allow consistent moisture conditions to be maintained to avoid discolouration. The following should be considered:

Water curing can cause streaks and non-uniform discolouration whilst run-off onto completed work can cause similar problems. Iron salts or similar impurities in the water may have disastrous effects.

Curing with wet hessian can also cause problems. Firstly, the hessian itself must be thoroughly washed before use to ensure it does not stain the surface. Secondly, it is necessary to ensure it is kept uniformly wet and in contact with the concrete surface to avoid discolouration.

being in uniform contact with the concrete surface; a combination of the pressure of the fluid concrete during placement and subsequent shrinkage of the concrete during drying. The darker areas are where the formwork remained in contact with the concrete surface and the lighter areas

are those where a gap developed, allowing the surface to dry more rapidly. With off-form finishes, however, it is often best to ease the formface from the concrete at an early age to prevent scabbing. When this is done, it is essential to ensure that all faces are loosened, uneven curing may otherwise result in colour variations.

Release Agents

Form oils and release agents are used when concrete is poured into a formwork. In-situ concrete is then poured into the formwork. Form oils and release agents are usually brush applied or sprayed and made from waxes and oils, such as paraffin wax, diesel fuel, or vegetable oil to assure that the concrete does not stick to the forms. This also reduces moisture from the concrete from being absorbed into the wooden forms.

Invariably residue will be left on the concrete surface when the moulds or formwork is removed and paint will not stick to this residue. While over time natural weathering will remove these waxes and oils, it can take several months to do so. Water blasting will not itself remove them detergents need to be used to remove formwork residue.

release agent should not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.

Table 1 Highlight of features that require particular attention when manufacturing concrete products, and possible defects that may result.

Item	Feature	Defect
Formwork	Preparation	Alignment, grout loss, joint stepping
	Absorbency	Crazing, colour
	Roughness	Scaling, chipping, spalling
	Cleanliness	. Discolouration.
Release Agents	Effectiveness	Scaling, chipping.
	Purity	Local discolouration, shade variability
	Compatibility	Retardation.
Mix Design	Low strength	Scour, scaling, chipping
	Excess cement	Crazing
	Proportions	Blowholes.
Placement	Inadequate ventilation	Air pockets, honeycomb
	Excessive drops	Segregation, steps
	Excessive vibration	Crazing, laitance
	Non-uniform	Plastic cracking
Curing	Impurities	Contamination
	Inadequate	Crazing, warping
	Uneven	Colour variation, efflorescence
	Excessive	Abrasion, scour

2.3.2 polished concrete finishes

Concrete polishing is the professional grinding of large concrete slabs. Smaller scale polishing, of concrete countertops and surface areas, employs many of the same techniques, but is usually not referred to as "professional grinding." In polished concrete, a chemical densifier is applied to strengthen the top most layer of the slab. The exact densifying process varies from manufacturer to manufacturer; most apply the densifier in the grinding process between the transition from metal to resin bonds, but there are those that apply the densifier at the end of the grinding process as well. The concrete surface is then polished with progressively finer grinding tools.

Polishing concrete can be done wet or dry. If done wet, no vacuum is required, but concrete slurry is produced and must be disposed of in a responsible manner as it is deemed a hazardous material most concrete grinding is done dry. However, when polishing dry, one must employ a filter equipped vacuum to capture the fine dust and silica that may be present in the air due to the grinding process. Since silica is harmful to the lungs and may lead to Silicosis, a reliable vacuum will ensure a safe working environment.

The three basic varieties of floor finishes for polished concrete include:

- exposed aggregate
- salt and pepper
- cream

Each of these varieties can have a matte finish or "high shine" depending if the use is commercial, industrial or residential. Finishing levels are reflective of the amount of work that needs to go into the floor. Generally speaking, the higher the finishing level, the more stages, tooling or products are used to achieve a higher end finish. Colors and dyes can also be used in conjunction with the polished system to further enhance the aesthetics.

Polishing Benefits

- A sustainable design flooring option.
- Uses materials already present.
- Eliminates the energy and additional materials to apply other flooring options such as carpet, wood, tile, etc.
- Low maintenance.
- More durable and easier to clean than many other flooring options.
- Increased slip resistance
- Reduces the opportunity for dust and dust mites for asthma and allergy suffers.
- Improves natural lighting with the reflective surface bouncing light around the room.
- Potentially reduces the need for additional interior lighting.
- Hard wearing surface has less opportunity for chipping, denting and wear and tear.
- Cleaner, healthier atmosphere for restaurants, hospitals and medical clinics, etc.

The following chart illustrates comparative costs based on 10,000 square feet from a survey conducted by the National Terrazzo and Mosaic Association. The examination of flooring costs was done over a 20-year period. Your costs may vary based on square footage, preparation needs, coloring, etc

	Wall-to-wall carpet	Ceramic tile	Vinyl or linoleum	Wood or wood laminate	Natural stone (such as slate or marble)	Polished concrete
Available in a wide spectrum of design options	Yes	Yes	Yes	Yes	No	Unlimited
Longevity and performance	Poor	Good	Good	Good	Excellent	Excellent
Ease of maintenance	Poor (needs frequent vacuuming; stains easily)	Good	Good (linoleum may need occasional waxing)	Good	Good (linoleum may need occasional waxing)	Excellent
Can radiate heat and store solar energy	No	No	No	No	Yes, depending on the material	Yes
Vulnerable to humidity and moisture damage	Yes	No	Yes	Yes	No	No
Can harbor mold, mildew, dust mites and other allergens	Yes	No	No	Yes (mold and mildew, if the flooring becomes wet)	No	No
Is a sustainable flooring alternative	No	Yes	Maybe (if using linoleum made from all natural materials)	Maybe (if made from reclaimed or FSC-certified wood)	Yes	Yes
Average cost per square foot installed	$3.38 - 6.61*	$11 - 22*	$2.64 - 5.64*	$8 - 10	$20 - 50+	$3 - 7 (for a 3,000-grit finish and the use of an impregnating sealer)
Average lifecycle cost	High	Low	Intermediate	Intermediate	Low	Extremely Low

Table 2 Comparing polished concrete versus other flooring materials

Source: Polished Concrete versus Other Flooring Materials

By Anne Balogh, The Concrete Network

2.3.3 plastered concrete finishes

Plastering is a process of applying one or more coats of mortar to a concrete surface, brickwork, stone masonry or lathing. It is durable such that it resists the penetration of moisture, is able to weather uniformly and could be made pleasing in appearance. These properties depend upon materials used, composition of mix, degree of mechanical bond between the plaster and the backing surface and workmanship.

Cement mortar has two types of bonds with its backing one being mechanical in which the mortar squeezes into the irregularities and gets interlocked when hardened and other due to the adhesive property of Portland cement on hardening. The degree of bond will therefore depend on the roughness of surface to be treated and the quality of cement and sand used in preparation of mortar.

Plastering is applied after monolithic concrete surfaces are roughened by hacking at close intervals with bush hammers or with a chisel and hammer and all dirt and loose particles are removed. (BATCODA) Monolithic concrete can be roughened with a heavy wire brush or a special scouring tool if forms are removed early.

Forms for concrete, that is to receive plaster, should not be given excessive mold oil coating. as it is likely to remain on the concrete, interfering with the bond (civilblog.org 2015). Special care must be taken to remove the mold oil coating before plaster is applied. Curing compound if used should also be removed completely before commencing the plasterwork

Tools are used for plastering are, Gauging trowel, floats, floating rule, plumb bob, straight edge, bushes, set square, sprit level, scratcher, plumb rules etc.

2.3.4 claddings and tiles

Concrete frame buildings can be clad with any kind of cladding material. Common cladding materials are glass, aluminum panels, stone sheets, and ceramic facades. Since these structures can be designed for heavy loading, one could even clad them in solid masonry walls of brick or stone.

The common floor tiles used are PVC tiles, Carpet tiles, Precast cement tiles, Slip resistant tiles, Marble tile, Marble chip flooring, Ceramic & mosaic tiles.

CHAPTER 3:

3. RESEARCH METHODOLGY

Qualitative research is an inductive approach where theories are generated out of collected data (Bryman and Bell, 2003). Qualitative methods are based on the facts which are socially constructed rather than objectively and are based on peoples' experience. Thus this method is most appropriate for this thesis since it uses peoples' experience.

To fulfill the objectives of this research work, the following strategies had been followed.

- **Literature review** is conducted on building finishing works and quality control from available books, journals, case studies, previous research works and standards are surveyed in order to have clear understanding of the subject matter as per international as well as Ethiopian context.
- **Data collection**: secondary data from available literature is used. Since the data is not collected on the study area it is only used for comparison
- **Economic analysis:** includes analysis of the economics related to the comparison of the recommended or standard finishing work to a defective system of finishing work.
- **Discussion:** based on the analysis made previously, the overall result of the study will be discussed.

CHAPTER 4:

4. RESULTS AND DISCUSSION

4.1 Economy in Making, Erecting, and Stripping Forms

The cost of forms includes three items: materials, labor, and the use of equipment required to fabricate and handle the forms. Any practice that will reduce the combined cost of all these items will save money. With the cost of concrete fairly well fixed through the purchase of ready-mixed concrete, little, if any, saving can be affected here. It is in the formwork that real economy can be achieved. Because forms frequently involve complicated forces, they should be designed by using the methods required for other engineering structures. Guessing can be dangerous and expensive. If forms are over-designed, they will be unnecessarily expensive, whereas if they are under-designed, they may fail, which also can be very expensive. Methods of effecting economy in formwork include the following:

- Design the forms to provide the required strength with the smallest amount of materials and the most number of reuses.
- Do not specify or require a high-quality finish on concrete surfaces that will not be exposed to view by the public, such as the inside face of parapet, walls or walls and beams in service stairs.
- When planning forms, consider the sequence and methods of stripping them.
- Use prefabricated panels where it is possible to do so.
- Use the largest practical prefabricated panels that can be handled by the workers or equipment on the job.
- Prefabricate form members (not limited to panels) where possible. This will require planning, drawings, and detailing, but it will save money.

- Consider using patented form panels and other patented members, which frequently are less expensive than forms built entirely on the job.

- Develop standardized methods of making, erecting, and stripping forms to the maximum possible extent. Once carpenters learn these methods, they can work faster.

- When prefabricated panels and other members, such as those for foundations, columns, walls, and decking, are to be reused several times, mark or number them clearly for identification purposes.

- Use double-headed nails for temporary connections to facilitate their removal.

- Clean, oil, and renail form panels, if necessary, between reuses. Store them carefully to prevent distortion and damage.

- Use long lengths of lumber without cutting for walls, braces, stringers, and other purposes where their extending beyond the work is not objectionable. For example, there usually is no objection to letting studs extend above the sheathing on wall forms.

- Strip forms as soon as it is safe and possible to do so if they are to be reused on the structure, in order to provide the maximum number of reuses.

- Create a cost-of-materials consciousness among the carpenters who make forms. At least one contractor displayed short boards around his project on which the cost was prominently displayed.

- Conduct jobsite analyses and studies to evaluate the fabrication, erection, and removal of formwork. Such studies may reveal methods of increasing productivity rates and reducing costs.

4.2 **Economy in Concrete Surface Repairs**

It is extremely difficult and costly to alter concrete once it is placed in position and allow to set. Constant and strict care is necessary during the progress of the work. Patching (eg filling tie-rod holes) and repairs (to correct defects) are carried out to improve the surface appearance or to reinstate the required minimum concrete quality and cover to the reinforcement, or both. Careful considerations should be given to the effect of repairs or remedial work on the surface appearance of the concrete.

Factors that affect the economy of repair include

- Repairs are carried out by skilled and experienced tradesmen.
- Where proprietary repair materials are used for color controlled finishes, trial repairs should be carried out to assess the color match.
- Bonding agents are often used to ensure adhesion to the substrate, particularly to high-strength concrete.
- For larger repairs requiring a concrete mix, the same coarse aggregate should also be used.
- Extensive repairs may require the area to be formed up. Forms used in this situation should have the same patterns and absorbancy

Blemishes that may require patching or repair include:

- **Blowholes.** These may be filled using a color controlled repair mortar and a spatula. The surface should be lightly moistened prior to repair and an earth-damp mixture forced into the hole.
- **Honeycombing.** The repair technique will vary with the depth and the area involved. In shallow areas, all loose or partly adhering material should be removed and the periphery of the area trimmed to a depth of 4–6 mm. The existing concrete should then be primed with a bonding agent and a suitable mortar packed into the hole and consolidated

- **Tie-rod holes.** Tie -rod holes are typically present over the entire surface. Holes may be made good or filled with either plastic or concrete plugs fixed in position with epoxy mortar. Alternatively, they may be filled with a dry-packed mortar rammed into position.

- **Minor grout runs, form scabbing and some hydration stains.** These can usually be repaired by rubbing the surface with a carborundum stone or using an angle grinder with an appropriate grinding pad. Acid etching, bleaching or similar treatments should be considered only as a last resort as the results may well exacerbate the problem instead of curing it.

- **Cracks.** Dormant cracks (unlikely to extend or open further) have traditionally been filled with a cement grout or mortar and live cracks (subject to further movement) sealed with a flexible material which can accommodate the movement in the crack. Repairs may highlight the crack, rather than conceal it, especially if widening of the crack surface is required to create a reservoir for the repair materials.

- **Crazing.** Crazing and other very fine cracks are difficult to repair effectively and in many cases the best option may be to do nothing. Autogenous healing of very fine cracks may occur with time. If the problem is an aesthetic one, rubbing down the surface with a carborundum stone followed by sealing with a water-repellent material, such as sodium silicate, may provide a solution. This should prevent dirt collecting in the very fine cracks and highlighting them.

- **Staining.** While staining from items such as the reinforcement may be overcome by using particular chemical cleaning products and methods, the bleaching action of the sun over time can also even out the color and remove stains. When there is staining due to aggregate containing iron oxide, the offending aggregate should be removed and the surface made good prior to treatment of the stain.

4.3 Cost and time comparison of the alternative concrete finishes

The cost will vary significantly with location and the skill of the operators and a variety of other factors. As a general guide the following we can compare based on,

- Construction time
- Labor cost
- Material cost

Table 3 Comparison of Alternative Concrete Finishing Based on Cost and Time

Type of finish	Additional Construction time	Additional Labor cost	Additional Material cost
Off-form Concrete Finishes	No	No	No
polished concrete finishes	Yes	Yes	No
plastered concrete finishes	Yes	Yes	Yes
claddings and tiles	Yes	Yes	Yes

CHAPTER 5:

5. CONCLUSIONS & RECOMMENDATIONS

This section presents the conclusions and recommendations drawn from analysis of the previous chapters.

5.1. Conclusion

- concrete surface finish alternatives are listed and the materials, tools and techniques for each method are specified and each alternative has its own advantages and disadvantages.
- All cast in-situ concrete construction do not need additional finishing works if the required care and detail is provided before, during and after construction
- The finishing works that require additional materials to be placed on top of concrete surfaces are taking more time and are costly than that of the finished concrete cast.
- In Ethiopia most of the finishing costs are reasonable to the poor workmanship and poor quality control during the construction period.

5.2. Recommendations

- An in-depth study shall be conducted in order to identify the efficient finishing technique identification method
- All finishing alternatives should be considered by the design team and detailed specification should be provided for the contractor to follow.
- The parties in the construction should identify between concrete finishing works and defect repair works.

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