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Management of Contracts for Durable Concrete Structures

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Abstract
Concrete meets the needs of sustainability in terms of economic, environmental, and social considerations. The material itself provides a wide range of benefits, including acoustics, vibration, fire, thermal mass, durability, security, sustainability, air tightness, and flood resistance. For many years, the vast majority of concrete structures around the world have performed satisfactorily, but progress has not been without its challenges. Quality control has deteriorated over time due to the use of poor quality ingredients, uncontrolled use of water in terms of both quality and quantity, poor quality shuttering, poor or no compaction, and inadequate curing. There is also a decline in the level of standard skill among the Artisans as well as those who supervise and accept the works. While older structures can serve adequately, newer constructions are showing signs of distress within a couple of years of completion. It is past time to pay closer attention to the fundamental issues. At the moment, attention is primarily focused on environmental attack, which is significantly reducing the lives of many concrete structures around the world, in many cases due to reinforcement steel corrosion. Deterioration of recent concrete structures has been observed at relatively faster rates, and has been attributed primarily to cracking.

Introduction

In most environments, concrete is thought to be chemically and dimensionally stable, leading to the belief that it is a material that is inherently durable and versatile. Concrete satisfies the economic, environmental, and social requirements for long-term sustainability. Acoustics, vibration, thermal mass, durability, security, sustainability, air tightness, and flood resistance are just a few of the advantages that the material provides on its own. It has a high compressive strength, abrasion resistance, and fire resistance, and it protects embedded steel from corrosion. It is also long-lasting, cost-effective, and is thought to require little maintenance during its service life. As a result of this belief, reinforced concrete has been used as the primary building material in many structures throughout the country. As a result, concrete should be properly specified to ensure that it will withstand the environment in which it will be used. This entails defining minimum cement content, maximum water-cement ratios, and concrete strength as long as the first two are met. Another prerequisite is good curing. Although many concrete structures have proven to be extremely durable over time, an increasing number have deteriorated quickly after being built. Even on a moderately exposed site, a 1954 survey found that reinforced concrete's trouble-free life is likely to be short if the reinforcement is not adequately covered. Due to the rapid expansion of the construction industry in the 1960s, such lessons were often forgotten, and today many modern concrete structures require extensive repairs and maintenance throughout their service life, with costs to the economy reaching 3-5 percent of GDP in some countries. The extent of the problems with premature corrosion of reinforced steel bars has only recently been realized, as has the actual deterioration of concrete. A variety of factors influencing the concrete's durability and degradation can be blamed for the premature corrosion of steel reinforcing. Assuming that concrete is indestructible has proven to be extremely foolish, as it is now widely recognized that concrete structures require regular maintenance to ensure their long-term viability.

Quality control has deteriorated over time as a result of the use of poor quality ingredients, uncontrolled use of water in terms of both quality and quantity, poor shuttering, poor or no compaction, and inadequate curing. The level of standard skill among Artisans as well as those who supervise and accept the works has also deteriorated. While older structures provide adequate service, newer structures show signs of wear and tear just a few years after they are completed. It is past time for serious consideration to be given to the fundamental issues.If the cube tests show that the strength is within the acceptable range, the concrete is considered acceptable. The strength of concrete is the only criterion used to assess its quality.

Management:

Durability is defined as a material's ability to withstand the service conditions for which it was designed over an extended period of time without significant deterioration. Concrete durability cannot be achieved by tinkering with a few aspects of concrete production. To create long-lasting structures, a holistic approach is required. It entails - I proper site selection, (ii) competent structural design and reinforcement detailing, (iii) improvements in concrete technology in terms of material selection, composition, and the process of producing concrete, (iv) construction system, (v) surface protection by proper drainage cover and water proofing, and (vi) periodic in-service inspection.

The permeability of concrete is one of the main factors influencing its durability. A suitable low permeability is achieved with strong dense aggregate by having adequate cement content, a low water/cement ratio, ensuring complete compaction of the concrete, and using the proper curing method. Proper design of the concrete mix is required to achieve the aforementioned goals. However, introducing the design mix without first constructing adequate infrastructure will cause more harm than good, especially for small and scattered works handled by smaller contractors.

Proper design of the concrete mix is required to achieve the aforementioned goals. However, introducing the design mix without first constructing adequate infrastructure will cause more harm than good, especially for small and scattered works handled by smaller contractors.In the case of large works involving a large volume of concreting, in addition to the introduction of design mix, the following must be insisted upon: I the use of a well-experienced contractor; ii) the use of a weigh batcher with the provision of an automatic water dozer; and iii) the use of only steel shuttering. Furthermore, for larger works/projects, a) only an approved shuttering system shall be used, and b) contractors shall employ a qualified Civil Engineering Diploma / Degree holder as site in-charge.

The shape or design details of exposed structures should be such that water drains well and there is no standing pool or rundown of water. It is also important to minimize any cracks that may collect or transmit water. Adequate curing is required to avoid the negative effects of early moisture loss. Member profiles and their intersections with other members must be designed and detailed in such a way that concrete flows easily and properly during concreting. Concrete is more susceptible to deterioration due to chemical or climatic attack when it is thin, under hydrostatic pressure from only one side, partially immersed, and at corners and edges of elements. The structure's life can be extended by adding extra cover to the steel, chamfering the corners, using circular cross-sections, or applying surface coatings that prevent or reduce the ingress of water, carbon dioxide, or aggressive chemicals. Inadequate durability is by far the most common cause of premature failure of concrete structures, yet it receives very little attention during the design process. In general, durability is covered by prescriptive code recommendations based on previous code clauses that have been arbitrarily tightened where case histories have revealed problems. Unfortunately, despite these specifications, the durability performance of concrete structures has not always improved. This appears to be due to a lack of understanding of what is required to ensure durability, as well as insufficient means of enforcing or guaranteeing specification compliance during construction. Material durability has long been a concern for engineers, but it is even more so today as environmental conditions change on a daily basis. There is no such thing as a material that is either durable or non-durable; it is the interaction of the material with its in-service environment that determines its durability (Gojrv, 2008).

Corrosion of steel and cracking

Premature chloride-induced corrosion of the reinforcement in many concrete structures remains a technical challenge. Actual concrete deterioration has only recently been accurately quantified, and the extent of the problems with premature corrosion of reinforced steel bars has been realized. This premature corrosion of steel reinforcing can be attributed to a variety of factors influencing the durability and degradation of concrete. This lack of durability is frequently related to a lack of proper quality control as well as special problems during concrete construction. As a result, before any rational approach to more controlled durability can be achieved, the issue of construction quality and variability must be thoroughly grasped. Set a requirement in the specification for new contracts, and ask your maintenance provider to agree on performance indicators within existing contracts. Setting a target for the entire maintenance activity will give the contractor more flexibility to achieve the most innovative and cost-effective results, such as using materials available in the region.

Concrete's strength and permeability characteristics are generally governed by its water-cement ratio, with a low ratio resulting in a high strength concrete with low permeability. Concrete mixture proportioning entails selecting a water/cement ratio to provide the required strength and then determining water and additive content based on workability and aggregate type. When considering high strength concrete, the aggregate type and aggregate-cement ratio must also be taken into account. It is common practice to specify a minimum cement content for structural concrete because cement provides a high level of alkalinity environment, which inhibits any form of corrosion of the embedded reinforcing steel. Too much cement content causes issues with early thermal contraction, which leads to cracking as a result of the temperature rise caused by cement hydration.

Deterioration of recent concrete structures has been observed at relatively faster rates, and has been attributed primarily to cracking. Cracking is associated with the use of faster-hydrating Portland cements with increased fineness and tricalcium silicate (C3S) content to support the high speed of modern construction. Because the heat of hydration depends on the chemical composition of the cement, C3S has a heat of hydration of 120 Cal/g versus 62 for C2S. (Neville and Brooks, 1987). The heat of hydration of cement and its rate can be reduced by reducing the proportions of C3S and C3A. The fineness of the cement affects the rate of heat development but not the total amount of heat liberated, which can be controlled in concrete by the amount of cement in the mix.

Interaction Mechanism

Therefore, concrete should be adequately specified to ensure the environmental durability to which it is exposed. This means that minimum cement content, maximum water cement ratios, and concrete strength are specified and are complementary to the two former characteristics. A further prerequisite is good curing. The use of reinforced concrete has been increasing dramatically in the last 40 years and is currently used for large building and civil engineering projects as predominant structural materials. Though many structures of concrete have exhibited excellent durability over the years, the number has deteriorated rapidly following construction. In a 1954 survey it was shown that the trouble-free lives of the armored concrete are likely to be short if the reinforcement cover is small in quantity even on a moderately exposed site. During its rapid expansion in the building industry, such lessons in the 1960s were often overlooked and many modern concrete structures today need significant repair and maintenance during their life span and the resulting economy cost in some countries reached 3-5 percent of the GNP. It has proved extremely foolish to assume that concrete is durable for ever, as it is now known that maintenance of concrete structures is necessary in order to guarantee its longevity.

Concrete durability is determined from the earliest stages of the mix design right through to the construction process. In the end, a lack of solid durability leads to an accelerated concrete deterioration. It is, therefore, obvious that improved durability cannot be achieved by improving the material characteristics by improving the complex nature of the environmental effects on structures alone. Architectural and structural design elements, implementation processes, inspection and maintenance programs, including maintenance preventive measures, must be considered. The relationship between concrete durability and performance is clearly based on structural and long-lasting designs, material and construction practice and service life coupled closely with concrete degradation mechanisms. The main factors influence durability and performance and the link between concrete durability and efficiency are examined.

The building quality and the suitability of the designs are primarily determining the durability of structures in reinforced cement. The interaction of material, structural and environmental impacts will result in concrete deterioration. Durability may be affected by the design, building or later on structure life.The relationship between performance, service life, durability and degrade must be understood in order to understand the role of degradation or degradation. By definition, degradation is the progressive decrease in performance over time while service life is the period after building during which the requirements for performance are satisfied. The degradation of both these materials must be defined, given that the reinforced cement is comprised of concrete and steel. Steel and concrete are interdependent, because steel is effectively protected from the high alkalinity of the surrounding concrete by electrochemical passivation, and steel in return provides the concrete's resistance to tensile strength. There is a growing awareness of the complex composite material concrete as environment and services can vary widely and the mechanisms of deterioration interact with material and structural influences dynamically. Betons as porous materials may interact with their environment by releasing the concrete compounds from the concrete or by entering the concrete with fluids and gasses, causing chemical or physical interactions. Aggressive materials attack and move to strengthen the exposed concrete surface. Concrete degradation research and its causes is widely reported.

Causes of Degradation

The principal causes of degradation of concrete are: Poor construction and detailing practices and design defects are important where external agencies can penetrate the concrete through construction defects to ensure a premature corrosion and degradation of the unsecured reinforcement of steel. Based on poor concrete working conditions, insufficient compaction, cold joints and poor cure, the most common construction defects do not provide the reinforcement design cover. Other defects in the molded concrete include honeycombing, blowholes, stained glass and pop, while abrasion, erosion, cavitation and repeated freezes and thawing are mechanical or physical processes influencing durability. The major causes of damage to fresh concrete in an early age are sedimentation, bleeding, shrinking crack and settlement cracking and drying shrinkage. Some of the mechanisms for deterioration relate to concrete ingredients such as alkaline aggregates, chemical attacks and freeze thaw scaling. The effect of rain, frost, sunshine and atmospheric pollution is a deterioration to the concrete outer skin. External agents, such as salt, acids, soft water, sulphates, frost and seawater all cause concrete deterioration. all cause concrete deterioration. This grouping also includes fire damage as it constitutes a specific external influence, which affects the concrete integrity negatively.

The corrosion of the reinforcement steel encapsulated inside the concrete causes the concrete deterioration caused by external agents. Combining chloride intake and carbonation are the dominant corrosive component in temperate climates, and this problem is addressed by the majority of North American and European corrosion research. Portland cement concrete paste is carbonated on all exposed concrete structure surfaces. Carbonation is a chemical reaction in which atmospheric carbon dioxide penetrates the concrete and reacts in the concrete paste to form carbonates with alkaline calcium hydroxide and other cement hydrates, thus releasing water or metal oxides depending on their product for hydration. The major component of the hydrated cement paste, calcium silica hydrate, is also charred with the calcium carbonate gel and a porous silica amorphous gel.

New Zealand Contract Model

New Zealand currently undergoes unprecedented building activities by the public and private sectors which are expected to continue over the next 10 years, at least for the infrastructure industry. If New Zealand is to get the best value from these works, best practice procurement principles for construction work is absolutely necessary. Research on current procurement practices in New Zealand, the United Kingdom and internationally has been contracted by New Zealand Construction Industry to compare, evaluate and recommend current practices. The findings of this research have been published by the NZCIC in October 2004 and are contained in the paper titled "Best Procurement in Construction and Infrastructure New Zealand Discussion Document."This study showed that procurement in construction in New Zealand tends primarily to be based on competitive price models focusing on:

- Economic goals (e.g. return on investment)
- Value over cost
- Short instead of long term results (building buildings, road, etc.
- Meet a need or opportunity immediately)
- Building costs and not entire lives
- Transfer of risk and liability to providers

It also found that it could lead to:

- Increased maintenance, rebuilding, and hidden costs
- Enhanced safety and health risks
- Quality design and integrity, health and safety, education, environment and Innovation is sometimes compromised or inhibited by exerting pressure reduce costs
- Bidders who look for all costs and underestimate actual costs related to work and price development at unsustainable levels Tendering stage in procurement
- Risk allocation or transfer to suppliers/providers inadequately (often through contracts for fixed prices) not always in a position to control or control administer them)
- Increased contracting and construction costs for suppliers/suppliers increased risks and/or cost recovery through greater variations Input of the client to the management of contracts.

The NZCIC therefore concluded that purely cost-based selection attracts long-term and value-depleting costs. It was noted by NZCIC that international recognition and growing acceptance is given that, in obtaining "Best Value" from contracting decisions, factors other than price reductions are key determinants of the procurement process. In public procurement in New Zealand this is particularly the case. This is demonstrated by new legislation on transport and construction, and changes to funding criteria in major public works, which introduce more value-driven selection criteria and processes. In view of these developments and taking the leading position, NZCIC determined that the principles behind best practice procurement should be identified for the best value results to be applied in developing best practice procurement guidelines in New Zealand. The conclusion of this process is this document.

The following definitions were used for the purposes of this document:

'Best practice' is defined as policies, systems, processes and procedures that are generally considered by pairs at any given time to be the practice which achieves the best result so that they can be adopted. The main objective when built services are procured is to obtain 'best value.' In this respect 'measured against financial and non-financial criteria 'best value' means the most advantageous value of the service provided. This includes buying a service that delivers optimal results and is cost-effective, taking the following non-financial characteristics into account:

- Quality
- Impact on the environment and on communities
- Completeness of design
- Innovation
- Innovation
- All-of-life issues like maintenance
- Opportunities for education and development
- Excellent practices of health and safety and
- Investment of capital.

It gives all parties fair returns on capital and effort and is the result of a process that satisfies all parties concerned. Lowest Cost means the lowest value of the dollar without taking into account the non-financial characteristics. The phrase 'Procurement Method' is the process used to deliver the construction projects for customers and users. The purchase of goods and services means far more than purchase. It covers the process from original design and concept planning to development, construction, maintenance and continuous surveillancePerformance.

The main advantage of best practice procurement procedures are better returns of higher asset value and lower lifetime costs when both monetary and non-monetary terms are measured. Through the following:

- Reduction of hidden maintenance costs, re-fitting construction, Renewal of infrastructure and the security risk of the asset's economic life•
- Increased quality and integrity of design, health and safety, education, environmental protection Management and innovation as a cost minimization pressure are replaced by positive incentives for good practice.
- Increased market sustainability as a means to reduce pressure on suppliers/providers. Costs are reduced and innovation and better design are encouraged. Health and safety solutions and opportunities for training.
- Enhanced risk management through appropriate risk allocation targeting. Mitigation for those who can influence or control them most. Enhanced contract results monitoring, thereby improving . Product/service quality information and performance information

Nor does this paper recommend an approach to 'one shoe suits all.' A variety of procurement options may be available for each project from a fully cost-based, fully quality or value-based procurement to a number of intermediate combinations. Customers are better placed to choose which approach is best suited for procurement. In spite of NZCIC' s conviction that purely cost-based procurement for best value results cannot be considered best practice, NZCIC recognizes that in some situations processes of selection based primarily on costs can be appropriated. In this context, the use of a cheapest method of selection could lead to the best value result if a customer: The scope and standard of work required can be defined easily and clearly, Can identify all projects and delivery risks easily, and mitigate them; Has experience working together with qualified professionals in a substantially similar project. Renowned providers/suppliers.

The principles are:

- Achieving the best value results is a focus of procurement processes. This is not necessarily the lowest cost, but the best design balance.
- Quality and integrity, building and "cost of life" to meet user demand.
- The service provider/provider is recognized as having to be in a position to obtain a sufficient return in order to remain viable. Fees should not be forced to the extent that consultants and contractors are unable to assign qualified employees for adequate time periods.
- It is clearly defined how to select the procurement method to use.
- The project is encouraged where appropriate to work on partnership approaches (to work together to improve design and construction, promote innovation and reduce accidents, and to costly maintenance work in the future).
- Clearly defined and transparent is the process for choosing suppliers.

- In the case of larger projects, account is taken of the advantages (for attributes) of pre-qualification by consultants and contractors. A systematic approach must also be adopted to monitor contractors' performance.
- The selection of suppliers is based on quality, as it helps to achieve best results.
- When the client was able to discuss project details with the best qualified company, the scope of the project is finalized (s).
- Health and safety practices/criteria, in accordance with all legislative conditions and the requirements of the New Zealand injury, for government agencies
- As part of the selection process, prevention strategy is incorporated.
- Included in the contractual specifications are relevant factors related to sustainable development and the environment.
- A recognized quality control system is complied with standard performance measurement indicators and use of tools like value management, risk management and lifelong costing are adopted.

Positive relationships include key advantages generated in quality or value-based procurement. From the beginning of the selection process the critical customer/contractor and customer / consultant relations are enhanced by the cooperation solution that is not adverse as in a selection process based on prices simply or predominantly. The customer and service providers come together from the beginning as a team to focus on value results – often a key ingredient in ensuring a quality project. Defined clearly and agreed upon mutually. The scope of the project is best determined if the client had the opportunity to talk thoroughly with the best qualified company about the desired project results. The number of alternative solutions to be examined; the extent of attention to environmental and consent issues; cost-effectiveness; time-frame for cost construction; social impact; cost for operation; and maintenance details can be achieved.

High costs. Fees will be fairer for the customer, the contractor and the consultant, since they are negotiated after fully identifying the value parameters of the assignment. Contractors and consultants are not under pressure to achieve a low cost result that can minimize efforts or compromise the quality and integrity of materials and designs. This means that the project will improve its built environment, minimize environmental impact, improve the safety, efficiency, durability and economy of its lifetime.• Cost efficiency in the long term. The right choice of a highly skilled contractor has a major impact on the project's overall cost. In the first 5% of its participation in the project, the contractors decide on the most important leverage for the life-cycle costs of the project.

The following are recommended guidelines for the best practice of procurement.

- Process of structured procurement
- Selection processes based on qualification
- Reports 3.
- Education and training
- Safety and Health
- Outcomes for the environment
- Assurance of quality
- Sustainability of Project/Industry
- Oversight and accounting
- Testing

General Observations in Concrete Construction

The following are some of the site practices which influence the durability of specific structures.

During the concrete construction of irrgation structures, it was observed that volume batching was carried out on the premises, in which cement was drained directly from the bags into the aggregate stack. Bags were only partially emptied leaving a certain amount in the bag. In this process. The bag was not essentially emptied in its entirety. In addition, sand was moistened by water in order to save cement. Even today, in small works this is the usual place practice.At another site in violation of the specification of the contract document, the contractor had brought coarse aggregate 60 mm in order to be used in the production of concrete for casting the RC slab. His arguments were that the quarry had only that size. The engineer in charge refused to accept the material very strictly and firmly and refused the material outright and asked him to remove the material from the facility. The entrepreneur finally produced the correct material and completed the work.When RC beam-column joints with 610 mm x 915 mm beam and column sizes and beam lengths 2 m, and column height 3 m were tested and measured for full scale, the start of treatment of the specimens was delayed one day, resulting in very high strength suffered. Specimen with the start of curing reached a strength of 28 days of 41.14 MPa at the correct time, but only 34,02 MPa with delayed curing. It is therefore better to start the treatment immediately after the end of the procedure. For a minimum of three days, the concrete specimens must be healed extensively with water. Neville (1996) says that poor curing is more effective in the strength of concrete made with the OPC. More about the 28-day loss of force appears to be directly related to water loss in the first 3 days. It is important to note that approximately half of the total heat between 1 to 3 days is released for the usual range of Portland cements.

Concerning the required strength the compaction of the concrete plays a crucial role. Weighing approximately 8.2 to 8.5 kg should be a fully compact 150-mm concrete cube. The strength of the concrete would be lower if the weight is lower than that. The contractor had used a hired needle vibrator during the concreting of one of the RC beam-column joints. The operator who accompanied the vibrator was not helpful. He used to switch the machine within a few seconds of the vibrator switch. His recurrent behavior prevented the concrete from being properly compacted. He argued that if it was operated for long time, the vibrator could be damaged. After strict warning and adequate explanation he was persuaded of the need and then cooperated well until the specimen were finished successfully.

Conclusion:

Cement and wood particles mixed panels were developed by a firm and it was claimed to be fasttrack construction material. Its use for earthquake-resistant housing construction has been recommended. A variety of tests have been performed on the material and used to check the structural adequacy as structural members. When the material was soaked in water, it absorbed lots of water and drastically reduced its strength. The fate of the building, built with this material in heavy rain and with wind, could not be difficult to imagine.

It was observed that gypsum block containing cement, lime, and gypsum was used as brick to construct partition wall in the ground storey of a building because of its advantage of fasttrack construction even though the cost was double that of the brick. The ground was flooded during a severe rainy day and the gypsum block was soaked with water, resulting in it becoming moist. In another location where the gypsum block was used to partition the space on the first floor of grid type construction. After construction the block was cracked vertically across the entire height of the floor, and even after several attempts, the contractor could not screen the block.

Only 5 mm or 8 mm bars in diameter are used as ties in columns at nearly all locations, however. Code prescribes a diameter of 16 mm as minimum to be used for ties. The Codes recommend that stirrups in concrete beams built in seismic zones be supplied with a 135° hook. However, it is observed that only 90° hooks are provided and that too not properly tied with main bars with binding wire. In the current situation, only re-rolling bars are used in residential buildings in the flat type. Tests conducted on re-rolled 12 mm diameter bars have disclosed that none of the tested specimens could achieve the minimum prescribed yield strength of 415 MPa prescribed in codes. Many of the TMT bars tested in the laboratory are below standard and the registered elongation of less than 20 percent was in contrast with that of good quality standards.

It has been observed that a certain diameter of bars cracked at the end load longitudinally during the testing of steel bars for mechanical quantities. This type of bar failure is highly damaging and affects the structural durability. The Young steel modulo was also found to be 80 kN/mm2 to 120 kN/mm2, compared to 200 kN/mm2 as standard. The modulus elasticity is usually 200 kN/mm2 in the design of concrete components. However, such a drastic decrease in value would make the member more flexible by increasing the deflection estimated in the design. The functionality of the structure is therefore significantly affected.

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