Importance of quality Assurance in the Building Construction Industry of Sri Lanka

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ABSTRACT:The building construction industry of Sri Lanka has shown a steady growth over the past couple of years due to end of terrorism and Tsunami Disaster. At present we can see many on-going building construction projects and planning new building project which are about to start. This situation has arisen due to urbanization, resettlement and economy growth. As a result, the demand for building materials, man power and machinery requirements etc. has shown a considerable increase.

Poor quality control will lead to structural failures arising from cracks, deformity, corrosion, , etc., In addition it will give rise to poor functioning of the services such as water leaks, unpleasant aesthetic appearance, and will ultimately affect the durability of the building.

1 INTRODUCTION

In the present market have many low quality building materials such as poor quality aggregate, bricks, cement etc. and many unskilled workers are employed at many construction sites in Sri Lanka. The above situation has directly affected the quality of the construction work.

The quality control procedure in building construction projects is based on tender documents, specifications, working drawings etc., therefore, the pre tender stage quality and standards of the work should be properly maintained. Therefore it is important to maintain quality control of the building projects from the inception of its design stage up to the completion of construction including the maintenance period.

Accordingly it is clear that quality control should be carried out in many of the vast areas in the construction industry. This paper lays focus on quality control in earth works, quality assurance in building materials and quality control in concrete works only

2 QUALITY CONTROL IN EARTH WORKS

One of the main activities of building construction sites is earth moving work. This includes excavation, filling and leveling of the earth work. The failure of quality control of earth works in building construction sites would lead to ground subsidence, cracks and structural failure in a part of the or whole buildings. Common issues pertaining to the earth moving work are given below:

(a) Selection of borrow materials for earth filling work.

The suitability of borrow materials can be checked by laboratory tests such as proctor compaction test, gradation test, liquid limit plastic limit etc. The validity of the entire test depends on sampling. The quality of the borrow materials in the barrow pit could be expected to vary in all directions. On the other hand, availability of an adequate quantity of the same quality borrow materials in the barrow pit is the governing factor for sampling. Therefore obtaining a representative sample form the borrow pit is very important. This has to be done by a well experienced officer. Therefore It is necessary to consider both quality and quantity of the borrow materials when taking representative samples. The properties of the borrow materials should comply with relevant codes and specifications. To minimize the delay during progress of earth filling work it is necessary to select borrow materials well in advance to the earth filling work because it will take a considerable time duration for selecting, testing, obtaining approval etc. of borrow materials. It is necessary to confirm the acceptance of borrow material delivered to the site by visual inspection against a reference sample by officer concerned.

(b) Spreading, leveling and compaction

According to the site condition it is necessary select suitable machine for spreading, leveling and compaction. The capacity of the machine and size of the blade are important factors for selection. The leveling of earth work is necessary to maintain proper slope and smoothen surface. This will eliminate water stagnation on the ground and facilitate fast smooth flow of storm water from the area.

The compaction of earth depends on the type of soil, water content and the applied force. The selection of compacting machines and equipment will depend on the soil type. The best compaction can be achieved at the optimum water content presence of the soil. This can be verified by laboratory tests. The optimum water content can be maintained at the site by using trial and error methods. The applied force can be changed by changing of the capacity of the compacting rollers and the number of passes over the soil. It is found that some construction sites use low capacity machines and equipment for earth moving work and this will lead to time, labour and money spent uneconomically. On the other hand it will slow down the progress of the work at the site.

In many building construction activities 95% compaction of proctor density is recommended. This can be checked by field density tests. Generally the earth filling should be controlled to ensure that the spreading of each soil layer limited to 225mm (approximately). After completion of each layer dry density has to be checked as specified in the specifications. The test locations have to be marked by the consultant of the project. All the laboratory testing and field testing should be arranged in time to maximize the progress of work.

It is necessary to prepare shop drawings indicating test locations by using x,y,z coordinates for each layer of soil strata for future reference. The failures of earth compaction to comply with the specifications may cause future settlements, erosions or subsidence.

(c) *Climate and Site Condition*

All the earth works can be done easily in dry weather condition. During rainy seasons it is necessary to pay more attention on the water content of the soil during the compaction leveling and spreading work. Excess of water or less water content presence in the soil is not suitable for compaction as well as spreading and leveling.

The earth work totally depends on site conditions. If there is peat or cohesive soil available at site it will be difficult to move machines on such soils for laying, spreading and compaction. In such circumstances it will be necessary to lay the first layer of soil to a loose thickness exceeding the specified limit. This is done in order to allow machine movements on the soil layer without any difficulties.

3 QUALITY ASSURANCE OF BUILDING MATERIALS

All the building materials used in the construction industry should be to acceptable quality standards. These materials should be incompliance with the relevant codes and specifications. The suitability of these materials can be confirmed by doing building material testing. In Sri Lanka we normally use SLS, BS and ASTM Codes for building material testing. Some of the building material tests are given below:

(a) Cement Tests

The parameters tested in accordance with SLS 107 are initial setting time, final setting time, three days mortar cube strength twenty eight days mortar cube strength, soundness test and fineness test.

In Sri Lanka we use both local cement as well as imported cement. There are two types of cement available in Sri Lanka. Those are bagged cement and bulk cement. The properties of both types of cement depend on the time between the manufacture and use. Therefore, it is necessary to confirm the above parameters by doing cement tests before use. It could be stated with personal experience that a cement test result could vary from laboratory to laboratory.

Therefore, when performing a cement test it is extremely necessary to select a recognized laboratory that is well equipped to perform the relevant test.

(b) Aggregate Test

Some of the aggregate tests used in the building construction industry are given below:

Fine Aggregate Tests

Grading test, clay silt and dust content, relative density and water absorption test

Coarse Aggregate Tests

Grading test, Flakiness index test, elongation index test aggregate crushing value test, aggregate impact value test, Ten present fine value test, soundness test clay silt and dust content test, water absorption, specific gravity test and organic impurities test.

The validity of the all these tests depend on sampling.

Fig 01 Coarse Aggregate Sampling

It is necessary to obtain representative samples for the testing. The above picture shows the method of obtaining a representative sample. It is noted that, he is very keen to get some portions of coarse aggregate from varies places in middle area of the heap.

(c) Steel Tests

The following parameters are determined under the tensile test for steel.

Yield stress /proof stress, tensile strength, elongation index and mass per meter run. Additionally checking dimensions of the structural steel sections with the specifications is very important.

(d) Concrete Tests

In all construction projects it is mandatory to carryout concrete cube tests as per the specification laid down. Most contractors do not take care to cast cubes according to the standard method. As a result there is a possibility of cube test failure even if the concrete quality is satisfactory. The oppositecould also occur. In such circumstances, there is a tendency to carry out Non Destructive Tests (NDT) test on the structure to establish the strength. This practice could lead to incorrect conclusion due to the limitation inherent in NDT tests. Therefore the need to carryout proper casting of test cube and testing them with the required accuracy cannot be over emphasized.

The reliability of NDT tests such as the rebound hammer test and Ultra Plus Velocity (UPV) test depends on many factors. By performing re bound hammer test it is possible only to determine the surface strength of the concrete. Result of a UPV test depends very much on the void ratio of the concrete tested. In view of the limitations of the NDT tests, they cannot be applied to absolutely determine the insitu strength of concrete. However, they can be used to make an assessment of insitu strength either on a comparative basis or by correlation with known reasons. The concrete core samples test appears to be the most reliable method of assessing the insitu strength.

(e) Cement block tests

Following parameters are tested in accordance with the SLS 855
The dimensions, wall thickness, web thickness, hollow volume, compressive strength, drying shrinkage and wetting expansion and water absorption.

According to the ICTAD specifications it is recommended to perform one test for every 1000 Nos. of blocks. In Sri Lanka there was no laboratory to do the drying shrinkage and wetting expansion test up to the year 2008.

Usually most engineers are interest only to perform the compressive strength test to evaluate the quality of cement blocks.

However many other requirements such as dimensions, water absorption etc. are important test for which cement blocks should be tested.

(f)*Cement brick tests / clay brick tests*

Important parameters for which cement bricks and clay bricks should be tested according to SLS 847 and SLS 39 are compressive strength, dimensions and water absorption

Stacking of clay bricks can be easily done if they have uniform dimensions. Most of the clay bricks are produced as a cottage industry in remote areas and hence dimension of the bricks may different from one another. In addition to that, clay bricks are not sufficient to meet the demand

forthem. Therefore, there is an increasing trend to use cement blocks.

(g) Timber Tests

Compression test, bending test, moisture content test and density test etc. are important for testing building timber according to SLS 1170.

The type and quality of timber cannot be verified easily when a load of timber is received at a construction site. Therefore, above tests are very important for quality control. All the timber should be treated before use to prevent termite attack, insect attack and fungus attack.

4 QUALITY CONTROL OF CONCRETE WORK

The strength and quality of the concrete depends on many factors. However it would be pertinent to comment on following factors.

(a) Quality assurance of the constituent materials

The suitability of the water, fine aggregate, coarse aggregate and cement can be confirmed by performing the relevant tests. At the same time sampling is also very important. The samples provided for testing should be representative of the material that is intended to be used.

These materials are received at the site from inception to completion of the projects from various sources, quarries and the producers. Therefore, quality of these materials should be visually checked at the site regularly against the reference samples. If there is any difference in between the material received at the construction site the reference sample, then it is necessary perform another test or otherwise the material may be rejected outright.

(b) Method of measurement of the constituent materials

(i) Measurement by volume

Volume batching of concrete by correctly measuring fine aggregate, coarse aggregate, cement and water is one of the main contributory factors to achieve the quality and the strength of concrete. As per the ICTAD specifications the volume batching at the site has to be carried out by using a standard gauge box having 250mmx400mmx300mm in size. The volume of one bag of cement is equivalent to the volume of the gauge box. Therefore by using gauge boxes batch mixing of fine aggregate and coarse aggregate can be easily done. Measuring them with pans is not recommended since volume cannot be specifically measured. The required quality of water depends on moisture content of both aggregates and the atmospheric conditions. Therefore, the required water content can be verified by trial and error method. One of the factors governing the slump test is the water content of the concrete. Therefore, the water content can be verified by the slump test for the particular aggregate used and the weather conditions at site.

(ii) Measurement by weight

Batching by weight is done at the batching plants and at places where the facility is available for measuring water and aggregate (fine and coarse) by weight. However, in Sri Lanka it is difficult to find the places where the aggregate meter and the water meter are available in concrete mixers. The quality control of concrete can be done properly by using this type of concrete mixers. The water quantity is verified as before by the slump test.

(b) Mixing Method

It has been observed that proper quality of concrete work cannot be assured by any manual mixing method and the adoption of this method of mixing of concrete cannot be recommended.

In Sri Lanka most of the sites use concrete mixing machines which can accommodate only half a bag of cement and hence it is difficult to maintain the quality control of concrete. Based on personal experience it is recommend to use concrete mixers which can accommodate at least one bag of cement (50 Kg.) to ensure quality. In a concrete batching plant all the materials are measured by weight and therefore mixing time and the mixing proportions could be easily controlled.

(c) Water cement ratio

The theoretical water cement ratio is approximately 0.33. This quantity of water in the concrete is necessary for the hydration process. There is some amount of water lost due to following reasons.

Water absorption by aggregates, water losses due to absorption of mixing machine and other devices and evaporation during the process of mixing, water losses due to absorption of conveying equipment, machinery and other devices and evaporation during the process of conveying. Water losses due to absorption of form

work and other devices and evaporation during placing of concrete could also be significant.

Water losses from the wet concrete may give rise to inadequate hydration of concrete unless additional water is introduced in to the fresh concrete before placement. Adequate water is required to maintain workability of the concrete and allow for the moisture losses described above. Normally for site use, water cement ratio is approximately equal to 0.50.

(d) Form Work

The form work should be water tight and should be able to bear the dead load of wet concrete and live loads. It should not be deformed, sagging or come out during the process of placing vibrating and casting of concrete. To fulfill the above requirements all the form work should comply with the specifications and BOQ requirements. Before concreting, form work should be checked with the guidance of a check list prepared for the project.

(e) Admixture

Admixtures are used in special situations such as in producing high strength concrete, under water concreting etc. An admixture can be defined as a chemical product which except in special cases is added to the concrete mix in quantities not larger than 5% by mass of cement during mixing or during an additional mixing operations prior to the placing of concrete for the purpose of achieving specific modification or modifications to normal properties of concrete.

Admixtures are commonly classified by their function in concrete but often they exhibit some additional action. The classification of ASTMC 494-92 is as follows.

Type A– Water reducing, Type B – Retarding, Type C – Accelerating, Type D – Water reducing and retarding, Type E – Water reducing and Accelerating, Type F – High range water reducing or super plasticizing, Type G – High range water reducing or super plasticizing and reducing or super plasticizing and retarding.

(f) Placing of concrete

In Sri Lanka placing of concrete done manually, using hoisting machine, pump cars, conveying belt, etc. During the placing of concrete it should not segregate. Additional water or other material should not be introduced to ease conveying. This will affect the strength of concrete adversely. During the placing the dropping height of concrete should be controlled to avoid segregations.

(g) Consolidation of concrete

Consolidation of concrete is done to obtain a dense concrete. It is also done to minimize voids in the concrete. In the building construction industry normally it is the normal practice used poker vibrators for compaction. The poker vibrator should be correctly handled to obtain better result.

(h) Curing of concrete

The curing of concrete is very important for strength developments. The best strength development can be obtained by curing at least 28 days.

5 CONCLUSION

Quality control in a building construction project is of utmost importance to upgrade the architectural appearance, improve safety and durability of the building and to ensure user compatibility. The final product has to fulfill the needs and aspirations of the user to occupy the building without any difficulty. This objective can be achieved by continuous quality control in all the stages of the project.

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