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# UNIT 9 INSPECTION AND QUALITY CONTROL

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## 9.1 INTRODUCTION

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Inspection is needed for maintaining quality in a construction project. Different aspects of quality are to be considered. Different types of inspection and quality control procedures may apply to different materials. An engineer should be conversant with all these procedures.

### Objectives

After studying this unit, you should be able to

- understand the need of inspections and quality control in construction projects,
- understand different aspects of quality control,
- know about principles of inspection, and
- appreciate what different considerations are required for quality control of different materials.

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## 9.2 NEED FOR INSPECTION AND QUALITY CONTROL

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Every operation is connected with the quality of the product. In the case of construction the quality of construction is to be maintained as per project specifications. It is important that quality requirements be satisfied and production schedules are met. The satisfaction of the owner of the project is mainly derived by the quality of the work.

Stiff competition in the national and international level of construction sector demands a high quality oriented attitude of engineers. However, the management is required to achieve the satisfaction of the owner by completing the project within the cost constraints for the project. Both of these things are dependent on properly integrating quality development, quality maintenance and quality improvement in construction. The integration of all these three aspects can be achieved through a sound quality control system.

### **9.2.1 Quality**

Quality is a relative term and is used with reference to the end use of the product. In the context of the construction field, this end product is what we construct. Sometimes quality is defined as the fitness of any constructed facility or structure for use at the most economical level.

As there may be difference in the perception of quality of an object, we have to specify the quality in a clear term. As mentioned above, quality may sometimes mean as the fitness for use. Sometimes it may be interpreted in terms of conforming to requirements. For example, a tourist building must be planned so that people staying inside it must feel its aesthetic appeal or beauty. If it does not conform to this requirement some people may term it not conforming (or matching) to the requirements.

Sometimes quality may be interpreted in terms of grade or degree of excellence for some structures. The quality of construction of a project is also dependent on the quality of several other parameters.

Quality of a constructed facility may be verified based on some instincts or factors. These may be considered as follows :

- Aesthetics
- Strength
- Durability
- Safety
- Economy
- Maintainability
- Reliability
- Degree of satisfaction of the end user
- Versatility of use for many purposes

### **9.2.2 Quality of Design**

Quality of design of a construction is concerned with the specifications which have to be conformed with. A good quality of design must ensure consistent performance of the facility for the entire life span of the facility. The design of the facility should be done in such a way that all possible modes of failures are considered and appropriate inputs are ingrained in the design to take care of them.

Quality design is a continuous process which results in good evaluation of an end product. Design features which are essential for a project are necessary to be considered. For example, a road without design features such as camber, superelevation or provision of side drains is not going to be evaluated as a good construction. Objectives of the owner for the construction of a structure, cost considerations, environmental considerations, etc. are some of the factors which may affect the design of a structure and hence its quality.

### **9.2.3 Conforming to Quality**

Conforming to quality means the quality of the product/construction to be of a required order. It is essential so that the construction goes on as per the satisfaction of the owner. Use of proper quality of materials, proper work sequences, proper types of equipment and inspections from time to time are

factors which should be considered. It is to note that a higher quality of design increases the cost but a higher quality of conformity with the design saves the investment.

#### **9.2.4 Quality of Performance**

It is connected with how well the constructed facility gives its performance. It depends on both the quality of design and the quality of conformance.

It may be easily understood that even a best design may not be able to provide us with something which is going to be the best in terms of performance if the quality of conformance is poor. The reverse is also true. A proper quality of conformance also can not provide a good quality of constructed facility if the quality of design of the facility is not good.

#### **9.2.5 Characteristics of Quality**

Quality of a particular object, such as a car, a book or a building, may be assessed by some parameters which are physical or chemical in nature. Sometimes the criteria may be abstract such as aesthetics or beauty of an object. These parameters are used to define the quality of an object.

Quality characteristics may be defined in terms of parameters which may be of the following types :

- Technical parameters – length, viscosity, etc.
- Psychological parameters – taste, beauty, etc.
- Time parameters – speed, life span, etc.
- Contractual parameters – safety, reliability, etc.
- Ethical parameters – honesty, integrity, nature, etc.

These characteristics may be measurable or non-measurable. This may be another criterion for classifying those parameters which may assess quality.

Quality control may be defined as a procedure by which we compare the actual quality of an object with the intended quality. If the actual quality is different from the intended one, especially if it is less, we have to take corrective actions. The intended quality is defined by some characteristics. The same characteristics of the actual object are measured. When these characteristics are compared, we can have an idea of whether the actual quality of the object is acceptable.

Quality control may be termed also as a systematic control of those factors which define the quality of an object. For example, we know that the strength of a structural member, such as a column, is dependent on the quality of materials which are used to construct that column. We shall have to control the quality of materials to control the quality of column. Quality control includes all such procedures, tools, specifications and the system of norms & specifications which are used to control the quality of an object.

Quality control is generally costly. We have to train people for making inspections, assessing quality of objects with the help of instruments which are sometimes purchase or hired on rent. Time also is spent on inspections. Inspections may sometimes affect the progress of work. Sometimes, we may have to dismantle some construction or part of construction which may be a drain on the resources of an organization. The cost of quality assurance should be considered and it should be the practice on the part of the contractor to establish high quality standards. Sometimes disputes may be there because of decisions made during

inspections which have to be sorted out. Getting these disputes amicably resolved also may sometimes be time consuming and costly.

There are some benefits of maintaining quality in the construction. These may be expressed as below :

- Increase in efficiency because of quality consciousness
- Reduction of scrap due to less number of items being rejected
- Easy identification of construction faults
- Decrease in cost in the long run due to benefits of quality control
- Creating quality consciousness in workers

Norms and guidelines are made for the quality specifications to be followed. For civil engineering construction, a variety of codes have been drafted by Bureau of Indian Standards, New Delhi.

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### **9.3 PRINCIPLES OF INSPECTION**

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Inspection means the checking of material or product at various stages of manufacture or construction of an object. It is done with respect to some pre-defined parameters and it tries to detect the faulty nature of the object. When we inspect something, we try to see the past history of construction and try to learn from our past experiences. Faulty objects are sorted out and are rejected. For example, those structural members, whose construction has been faulty, may be dismantled and reconstructed. There may be different aspects which may be followed. For example, the quality of a beam specimen may be faulty because the concrete in that beam may not be of the chosen grade. It may be considered faulty if the detailing of reinforcement (i.e. how the reinforcement is to be placed in the beam) also is faulty. Such beam members would be discarded, dismantled and reconstructed.

Inspection should not be confused with quality control. Inspection is a way or method of maintaining the quality of the object being constructed or produced. Controlling the quality is what is termed as quality control. Quality control is a wide term which involves inspections at various stages of construction. Basically, when we consider the quality control of some object, we always have some future object in mind and we try to find out the ways as to how to control the quality of that object, to be produced in future. This is why, the quality control people are provided with instructions prior to the production or construction of some object or some building.

Inspections give us needed inputs to control quality. If the quality of an object is found to be not as per expectations, we have to take remedial steps. Inspections check the quality of past constructions and quality control norms or specifications are provided for the future constructions. Inspection is an act of checking the objects or items, sorting out and finding out the faulty item. Quality control is a broad term which includes inspection as an activity out of a number of activities carried out for the purpose.

Inspections are carried out using precise equipment and instruments. These devices or tools are used to measure those characteristics which define the quality of an object. Using such devices, we can ascertain the quality of past constructions and judge if those objects, which were constructed, were as per accepted norms and

specifications. Inspection is mainly carried out by people who are responsible for it. They must know the norms and specifications, characteristics to be measured and should know how to use different devices and tools to examine the quality of a construction.

For inspecting the quality of construction, non-destructive test procedures have been established. In such procedures, which are termed as NDT procedures, we can test the quality of construction without deforming a structural element.

### **SAQ 1**

- (a) What is the need for quality control in construction?
- (b) What are the principles of inspections for quality assurance? Write briefly.

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## **9.4 MAJOR ITEMS IN CONSTRUCTION JOB REQUIRING QUALITY CONTROL**

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To understand the aspect of quality control in construction, it has to appreciate that construction industry is somewhat different from other manufacturing industries. The objects created or constructed in this sector are most of the times unique in the sense that the structures are never the same or the exact replica of one another. Two buildings, two bridges, two roads may be chosen at random and in each case we would find that there are differences or variations.

There are certain considerations which should be kept in mind when we consider quality control in civil engineering construction.

Quality of construction is dependent, to a great extent, on

- The quality of materials which are used in construction
- The expertise of workers
- The technology adopted in construction
- Number, type and quality of inspections
- Quality consciousness of people
- Funds available for construction and quality control
- Time available for quality control procedures
- Existence of norms and guidelines for assessing quality of construction of a particular type
- Experience and expertise of inspectors
- Quality of design
- Nature of the construction project

We can see that some activities in a construction work may be of a repetitive nature. Some activities are taken up only for some times. Concrete mix making may be a routine affair at a construction site. We can understand that quality control norms may be different when we compare two materials out of which one is a factory made item and the other one is a site made material. It may be the case of some steel channel section and the concrete mix. We should be more concerned for the quality control exercised for the making of materials which are manufactured at the site. This is due to the reason that illiterate workers may not know the correct manner of doing something in a right way. For some materials, we have to be extra vigilant for quality as these materials may be very important for supplying strength to the construction. If the quality of concrete is not good, we can not expect a good quality of construction.

Quality of construction materials should be good. Guidelines should be followed in the assessment of quality of these materials. Some common materials which are used for construction are given below :

- Cement
- Fine and coarse aggregates
- Chemical admixtures
- Timber
- Steel
- Soil of a site
- Bricks and stones

Standard guidelines, formed by standard codes, are available. These guidelines supply us with the tests conducted to assess the quality of these materials. Tests should be conducted on these materials and faulty materials should not be used.

Quality of construction procedures and processes adopted also should be considered in the context of quality control.

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## **9.5 STAGES OF INSPECTION AND QUALITY CONTROL**

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Specifications for quality are available in Indian standards formulated by Bureau of Indian Standards, New Delhi. Different types of construction works are dealt with in different ways and different tests to assess their different quality characteristics are available. In different types of construction works or jobs different stages may be recognized. For example, if we wish to make a reinforced concrete beam structural member, we have to go through different stages such as providing supports to the form work, making of form work, cutting or reinforced bars for the beam, putting the reinforcement in the formwork, mixing of concrete, pouring of concrete in the formwork, vibrating concrete, curing concrete, etc. There are different types of guidelines to oversee each stage so that the quality of the beam is of a right type. We should appreciate that it shall be difficult to maintain the overall quality if quality is not maintained in some of these stages. We have to monitor quality of each and every stage to get the required quality of the concrete member.

Salient points are given below regarding different stages and quality control aspects required to be considered in some general construction operations.

### **9.5.1 Earth Work**

#### *Stages*

- Measurement of dimensions in different directions in terms of height, width and length
- Excavation of soil
- Determination of soil properties
- Compacting soil

#### *Quality Control Considerations*

- Accurate measurements with precise instruments
- Use of good equipment
- Use of standard procedures for testing of soil
- Use of equipment for compaction

### **9.5.2 Masonry**

#### *Stages*

- Measurement of dimensions in different directions in terms of height, width and length
- Construction of masonry
- Curing of masonry work

#### *Quality Control Considerations*

- Use of good quality materials
- Use of right construction procedures and correct bonds
- Employment of people with experience and expertise
- Adequate curing of masonry

### **9.5.3 Reinforced Cement Concrete (RCC)**

#### *Stages*

- Measurement of dimensions in different directions in terms of height, width and length
- Creation and installation of formwork
- Provision of reinforcement
- Mixing of concrete
- Casting of concrete
- Curing of concrete

#### *Quality Control Considerations*

- Use of good quality materials
- Use of right construction procedures
- Employment of people with experience and expertise
- Correct detailing of reinforcement
- Adequate curing of concrete

### 9.5.4 Sanitary and Water Supply Services

*Stages*

- Measurement of dimensions in different directions in terms of length as well as area covered
- Procurement of sanitary and water supply items
- Installation of these items correctly
- Testing of these items

*Quality Control Considerations*

- Use of good quality materials and items
- Use of right construction procedures
- Employment of people with experience and expertise

### 9.5.5 Electrical Services

*Stages*

- Measurement of dimensions in different directions in terms of length as well as area covered
- Procurement of items
- Installation of these items correctly
- Testing of these items

*Quality Control Considerations*

- Use of good quality materials and items
- Use of right connection procedures
- Employment of people with experience and expertise

Various types of effects, due to inadequate quality control in construction, generally seen in various facilities already constructed are provided in Table 9.1.

**Table 9.1 : Various Effects due to Inadequate Quality Control**

<b>Cause/Effect</b>	<b>Ponding of Water Taking Place in a Slab</b>
Remedy/Precaution	The effect of ponding may be due to insufficient slope provided in the slab. This may create problems while washing floors. If ponding takes place in the topmost slab, it may be even more troublesome in the rainy season.
<b>Cause/Effect</b>	<b>Cracks Appearing in Concrete Structural Members in a Structure</b>
Remedy/Precaution	The reinforcement detailing in the structural members of concrete should be correctly provided as a precaution. If the cracks are detected, proper safeguards should be taken with the expert advice. In any case, cracks should be properly sealed so that corrosion of reinforcement inside does not occur.
<b>Cause/Effect</b>	<b>Peeling Off of Plaster, Crumbling of Concrete of Structural Members</b>
Remedy/Precaution	Plastering of the surface should be redone in the area where the peeling off has taken place. Fresh cover concrete from where crumbling of concrete has taken place in the structural elements should be provided.

	Crumbling of concrete is considered as a falling hazard also.
<b>Cause/Effect</b>	<b>Efflorescence in Walls, Peeling of Plaster, Corrosion of Cement Plaster of the Walls</b>
Remedy/Precaution	Efflorescence may be due to seepage in the walls. The seepage in the walls should be arrested. Portions, where plaster has peeled off, should be replastered. Wall portions where plaster has lost its strength may be subject to guniting or may be reconstructed.
<b>Cause/Effect</b>	<b>Walls of Great Thickness Showing Rupture, along the Length of Wall, in the Middle Portion</b>
Remedy/Precaution	Walls may be provided with through stones or reinforcement bars going along the thickness of walls. This gives them safety in vibratory situations such as earthquakes.
<b>Cause/Effect</b>	<b>walls having Less Strengths in certain Portions, such as Near Corners, Walls of Large Slenderness Ratio</b>
Remedy/Precaution	Proper bond should be provided in the walls, especially where two walls meet. Walls of large slenderness ratio should be strengthened as under earthquakes or under impact loads these may fail and cause accidents. Such walls may preferably be reinforced.
<b>Cause/Effect</b>	<b>Leakage Due to Water Tank, Seepage at the Top of Mumty Slab Especially in Rainy Season</b>
Remedy/Precaution	Leakage of water from the water tank should be arrested. Pipe joints should be checked and faulty ones should be repaired. Mumty slabs should be repaired to avoid ponding of water.
<b>Cause/Effect</b>	<b>Falling Hazards Due to Parapet Walls and Water Tanks at the Top</b>
Remedy/Precaution	Parapet walls should be repaired to give them added strength. They may be reinforced during reconstruction. The pillars of water tanks should be made of adequate strength so that they can take the shear stresses during earthquake conditions.
<b>Cause/Effect</b>	<b>Seepage from Water Tank Walls</b>
Remedy/Precaution	The walls of the water tanks should be repaired suitably. Ferrocement treatment may be given to the walls of tanks to make them impervious to water

Some figures showing these conditions are provided at the end of this unit.

## SAQ 2

- (a) Write various considerations for inspection of any three materials used in construction.
- (b) What types of effects may be seen in structures due to bad quality of construction?

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## 9.6 SUMMARY

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Inspection is needed for maintaining quality in a construction project. Different aspects of quality are to be considered. Different types of inspection and quality

control procedures apply to different materials. Quality control considerations should be given due importance in construction projects.

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## **9.7 ANSWERS TO SAQs**

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Refer the preceding text for all the Answers to SAQs.