AR 12 56 - STRUCTURAL DESIGN-1.

NOV 2014

a) ADVANTAGES AND DISADVANTAGES OF RCC

The Reinforcing steel is placed in forms, and fresh concrete is poured around it. This solidified composite mass is called Reinforced cement concrete and it abbreviated as R.C.C. RCC is a composite material which is made up of concrete and steel reinforcement. The steel is placed in the tensile zone of the structure and it take the tensile stresses.

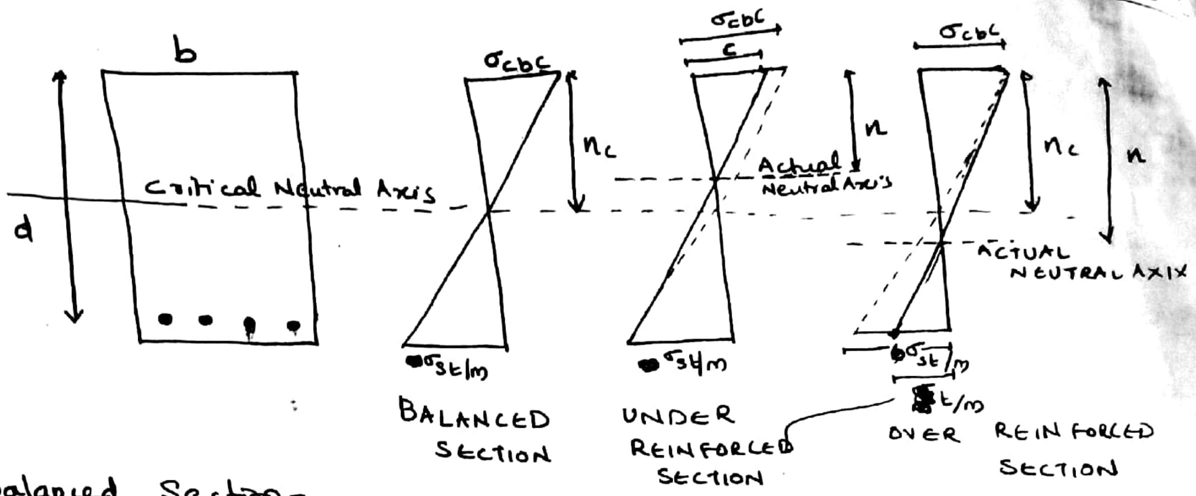
Advantages are :-

1) Strength :- R.C.C has very good strength in tension as well as compressi
2) Durability :- R.C.C structures are durable if laid and designed propel. They can last upto 100 years.
3) Mouldability :- R.C.C sections can be given any shape easily by proper designing the formwork. More suitable for architectural requirements.
4) Ductility :- The steel reinforcement imparts ductility to the R.C.C stru
5) ECONOMY :- R.C.C is cheaper as compared to steel and prestressed co maintanance cost is low.
6) Transportation :- The raw materials for R.C.C are easily available and can be transported easily.
7) Fire resistance :- R.C.C structures are more fire resistancant than steel and timber.
8) Permeability :- R.C.C is almost impermeable to moisture.
9) Seismic Resistance :- Properly designed R.C.C structures are extreme resistant to earthquakes.
10) Stresses :- R.C.C helps in preventing temperature and shrinkag stresses.

Disadvantages are :-

1) RCC structures are heavier than ~~other~~ structures of other mater ~~like~~ such as steel, wood, glass etc
2) R.C.C needs a lot of form work, centering and shuttering to a fixed thus requires lot of site space and skilled labour.
3) Concrete takes time to attain its full strength. Thus RCC structures

b) UNDER REIN FORCED , OVER REINFORCED AND BALANCED Rcc VARIOUS



Balanced Sections

A balanced Sections is that in which stress in concrete and steel reach their permissible value at the same time. The percentage of steel corresponding to this section is called as balanced steel and the N.A is called as critical neutral axis.

Here, $n = n_c$

N.A depth factor, $K_c = \frac{m\sigma_{cbc}}{m\sigma_{cbc}+\sigma_{st}}$

Moment of Resistance $M_R = \sigma_{st} A_{st} jd$

or

$M_R = \frac{1}{2}\sigma_{cbc} j k_c bd^2$

Under reinforced Sections

In this, the percentage of steel is less than that ~~of~~ provided in balanced section. So the actual N.A shifts upwards. In under reinforced sections the stress in steel first reaches the permissible value, or the concrete is under stressed.

Here, $n < n_c$

Moment of Resistance, $M_R = \sigma_{st} A_{st} jd$

∴ the failure is ductile because the steel fails first and sufficient warning is given before collapse. Due to economy and ductile failure these sections are preferred.

Over reinforced Sections

In this, the % of steel is more than that provided in balanced section. So the actual N.A shifts downwards. In this the stress in concrete reaches its permissible value while steel is not fully stressed. The failure is sudden. The over reinforced s/n is uneconomical and are not preferred.

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1) VARIOUS LIMIT STATES AND THEIR IMPORTANCE [SECTION-5 of IS 456:2000]

These are three design methods for desiging RCC structures: Working stress method (WSM), ultimate load method (ULM) and limit state method (LSM). While WSM give satisfactory performance of the structure at working loads, it is unrealistic at ultimate sta of collapse. |||ly ULM provides safety, it does not guarantee satisfacte servicability requirements @ service loads. Limit state method is an ideal method which takes into account not only the ultimate strength of the structure but also the servicability and durability requirements. Different types of limit state are

1) Limit state of collapse
   a) limit state of collapse in flexure
   b) " " " " " compression
   c) " " " " " " and uniaxial bendin
   d) " " " " " " and biaxial bendi
   e) " " " " " shear
   f) " " " " " bond
   g) " " " " " torsion
   h) " " " " " tension.

2) Limit state of servicability
   a) limit state of deflection
   b) " " " cracking
   c) other limit states such as vibration, fire sal

Limit State of collapse.

Limit state of collapse of a structure could be assessed from rupture, buckling due to elastic, plastic instability or overturning. The resistance to bending, shear, torsion and loads shall not be less appropriate value at that section using appropriate partial safety f

Limit State of servicability.

It relate to the performance or behaviour of structure a working loads.

The Design of a section is based on the considerations of limit states of collapse on ultimate loads and on servicability limit state of deflection and cracking under service loads. Durability is ta care by prescribing appropriate grade of concrete, nominal cover h'.

e) DOUBLY REINFORCED SECTION

~~If these applied~~ A Singly reinforced section has a limiting value of moment of resistance, corresponding to the limiting value of steel reinforcement. If the applied moment M_u is larger than M_{ulim}, $[M_u > M_{ulim}]$ two alternatives are available:-

- To increase the depth of the section.
- To provide compression reinforcement.

In many cases, the maximum value of depth of the section may be limited or restricted due to architectural considerations. In that case only alternative left is to provide reinforcement in the compression zone. Such kind of sections in which reinforcement is provided both in tension zone and compression zone is called as doubly reinforced section.

It is provided in the following circum-stances:-

1) When there are architectural considerations on the depth [Such as head room requirements, aesthetics etc.]
2) Restriction in the depth at the location of beam at plinth level, along with the provision of ventilator between the ground level and the bottom of plinth beam.
3) In a continuous beam floor system, where the beam acts as T-b in the midspan and acts as a rectangular beam at the Supports where the B.M may be much greater than at the mid span.
4) Where it is required to increase the stiffness of the beam.
5) It is found that the compression steel increases the rotation capacity and ductility.

Write note on :-

1) Decay of timber:-

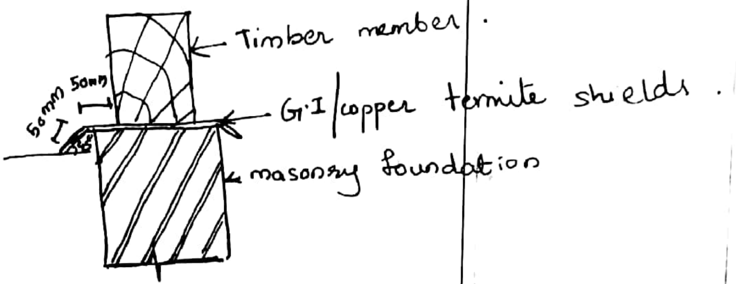
The disintegration of timber substance due to the action of timber destroying agents is known as decay. The various timber destroying agents are fungi marine borers and insects. The fungi is most destructive. The fungi develops in damp places. The fungi is a kind of plant life. It grows in the form of hair like threads. The fungi travels through the timber and it renders the timber ultimately into powder. when the timber is maintained either completely dry or saturated, it lasts long. If it is alternatively wet and dry, and used in dark, damp and unventilated conditions, it deteriorates very soon. If timber is used in ground, it also deteriorates soon. The timber structures used for marine works are attacked by marine borers. The decay of timber also takes place by rots. There are two types of rots;- dry rots and wet rots. If the timber is placed in unventilated Places, where the air is confined, the decay takes place due to dry rot. wet rot attack living trees. Timber also deteriorates by attack of white ant and termites. They get into the structures and destroy the structure

2) Preservation of timber:-

- Preservation is essential to avoid decay of timber. The pores are filled up with preservatives. The preservatives exclude moisture from penetrating below the surface.
- Various antiseptic chemical compounds are injected to the pores [compounds such as coal tar creosote / creosote oil / dead oil / coal tar Process of using coal tar is known as creosoting. These are used for exterior use such as railway sleepers, piles, poles etc.
- Mercuric chloride is also used as preservatives. It is also injected to the pores. It is a form of corrosive sublimate. It prevents destruct. by ants and sea-worms also for dry rot. The process of using this compound is known as kyanizing. [sodium fluoride, zinc chloride & copper sulphate are also used.]
- Ascu developed by Forest Research Institute, Dehradun are also preservatives. It is in powder form. A solution is prepared by mixing

six parts of Ascu by weight in a 100 parts of water by weig... The solution is odourless. After treating it can be painted, var... polished or waxed. It can also be sprayed on the wood pieces can be soaked in the solution tank.

- Termite shields are provided when untreated timber is used in mason... foundation. It is provided by providing galvanized iron/copper sheet which acts as damp proof course. This prevents termite and white ants to enter the timber structures.



h) STEPS INVOLVED IN THE DESIGN OF TIMBER BEAMS

All timber members should be designed without exceeding the relevant stresses specified in the Indian Standard Code 883 : 1994. The beams designed shall be capable of sustaining, with due stability and stiffness the whole dead & imposed loads. The designed member shall be investigated for the following:-

a) Bending strength.
b) Maximum horizontal shear.
c) Stress at the bearing
d) Deflection

a) check for bending

- Effective span is found out by taking distance from support plus ½ of the required length of bearing.
- Flexural strength shall be in accordance with.

$f_{ab} = \frac{M}{Z} \leq f_b$

- Form factor K_3 is applied for rectangular beams having depth more than 3..

$$K_3 = 0.81 \frac{D^2 + 89400}{D^2 + 55000}$$

- Depth of the beam shall not be more than 3 times the width
- Width of the beam shall not be less than 50mm or $\frac{l}{50}$ whichever great...

b) Maximum horizontal shear

for rectangular beam, $H = \frac{3V}{2bD}$

where $V = \frac{W}{2}\left(1 - \frac{2D}{l}\right)$ for udl

$$V = \frac{10c(l-x)\left(\frac{x}{D}\right)^2}{9l\left(2 + \left(\frac{x}{D}\right)^2\right)}$$ for concentrated loads.

This shall be under the limiting value obtained from Table 1 IS 883:1994

c) Stress at the bearing.

Stress is found out by dividing the Reaction at supports by the bearing Area.

Reaction at supports = $\frac{wl}{2}$ [for S.S beam with udl]

" " " = $\frac{W}{2}$ [for S.S beam with concentrated loa

Bearing area = $l \times b$

Bearing stress = $\frac{\text{Reaction at supports}}{\text{Bearing Area}}$.

This shall be in accordance with the value obtained from table of IS 883:1994.

d) Deflection

The deflection shall not exceed $\frac{l}{360}$ for members supporting brittle materials like gypsum tiles etc.

and the value shall not exceed $\frac{l}{240}$ for other flexural members.

and the value shall not exceed $\frac{l}{150}$ for freely hanging in case of cantilevers.

$$\delta = \frac{KWL^3}{EI}$$

$K = \frac{1}{3}$ for cantilevers with free end.

$K = \frac{1}{8}$ for cantilevers with udl.

$K = \frac{1}{48}$ for S.S beams with point load at centre.

$K = 5$ for S.S beams with udl.

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2) CHARACTERISTICS STRENGTH OF STEEL

The term characteristic strength means that value of the strength of material below which not more than a minimum acceptable percentage (5%) of the test results are expected to fall. There is only 5% probability or chance of the actual strength being less than the characteristic strength or in other words, the characteristic strength has 95% reliability.

characteristic strength = Mean strength - k × standard deviation

$$f_k = f_m - k S_d \quad [k = 1.65]$$

until the relevant IS specifications for reinforcing steel are modified to include the concept of characteristic strength, the characteristic value shall be assumed as the minimum yield stress / 0.2 percent proof stress specified in the relevant IS specification. The characteristic strength of steel is designated by symbol f_y (N/mm^2)

characteristic strength of concrete

It is denoted by f_{ck} (N/mm^2). For ordinary concrete, M10, M15, M20 the compressive strength is 10, 15, 20 N/mm^2 respectively. In this symbol 'M' represents the concrete mix, and the number refers to the specified characteristic compressive strength of 150mm size cube at 28 days expressed in N/mm^2. The design values should ~~not~~ be based on 28 days characteristic strength of concrete unless there is evidence to justify a higher strength for a particular structure due to age.

3) ASSUMPTIONS IN LIMIT STATE METHOD FOR SINGLE REINFORCED SECTIONS [REFE... Cl 3... IS 456:20... Page 69]

1) Plane sections normal to the axis remain plane after bending.

2) Maximum strain in concrete at the outermost compression fibre is taken as 0.0035 in bending.

3) Tensile strength of the concrete is ignored.

4) The relationship b/w the compressive stress distribution in concrete and the st... in concrete may be assumed to be rectangle, trapezoid, parabola or any other shape which results in the prediction of strength in substantial agreement with the results of tests. For design the compressive strength of concrete in structure shall be assumed to be 0.67 times the characteristic strength of

6) FIVE FACTORS TO BE CONSIDERED WHILE DESIGNING THE STAIRCASE

1) LOADS ON STAIRCASES

a) Dead loads which include the self weight of the stair slab (waist slab), tread, risers and self weight of finishes.

b) Live loads to be considered are specified in IS 875 : 1987 part II
for residential building, udl of L.L 2 to 3 kN/m^2 depending
for public buildings, udl of L.L 5kN/m^2 is specified in code.

2) Effective span of stairs

When stair flight is supported at the ends by landing beams, the effect span is the projected horizontal distance b/w the centre lines of landing beams.

When stair slab is supported on each side by side wall or stringer beam on one side and beam on the other side, the effective span is the horizontal distance between the centre to centre of supports.

3) DISTRIBUTION OF LOADS

This depends on type of spaning. In case of open wells where spans partly crossing at right angles occur, the load on areas common to any two such spans may be taken as ½ in each direction. In case of flights or landing are built into walls at a distance of not less than 110mm are designed to span in the direction of the flight, a 150mm strip may be deducted from loaded area and effective breadth of the s/n increased by 75mm for the purpose of design.

4) ESTIMATION OF DEAD LOAD :- This consist of waist slab and steps

Dead weight of waist slab :- The D.L, w' per unit area is calculated at rt angles to the slope and then the final load (W_1) is obtained by increasing w' by the ratio $\frac{\sqrt{R^2+T^2}}{T}$ where R is Rise & T is tread.

Dead weight of step :- It is obtained by treating the step to be a equivalent horizontal slab of thickness to half of Rise $\left(\frac{R}{2}\right)$. Thus W_2 is obtained

Total D.L = $W_1 + W_2$

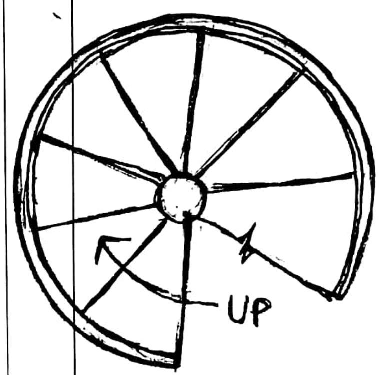
5) Minimum width of stair, tread, ~~risers~~ shall not be less 1.2m and 30cm respectively.
~~minimum~~ height of riser shall not exceed = 15cm.

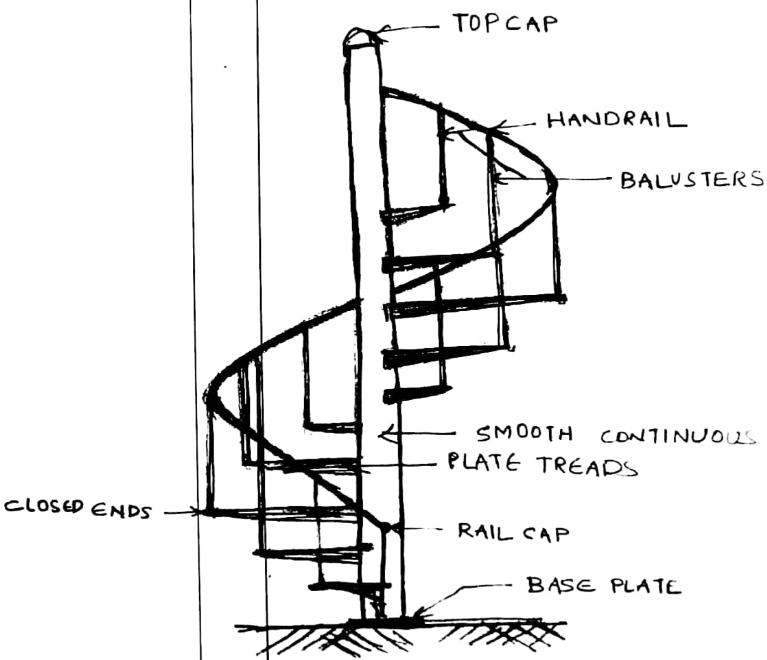
concrete in cube. The partial safety factor $\gamma_m = 1.5$ shall be applied to this

5. The maximum strain in the tension reinforcement in the section at failure not be less than $\frac{f_y}{1.15E_s} + 0.002$.

6. The stresses in the reinforcement are derived from representative stress - strain cu for the type of steel used. Partial safety factor $\gamma_m = 1.15$ shall be applied

5. SKETCH THE HELICAL STAIR CASE : MENTION ITS PARTS



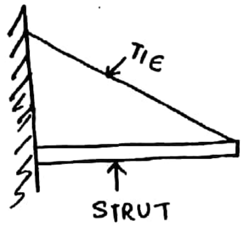


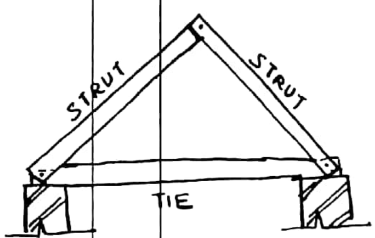
7) SHORT NOTE ON ALLOWABLE STRESS OF CONCRETE AND STEEL

The Working stress method of design of structural concrete members is based on elastic theory. The materials are assumed to behave in linear elastic manner in working stress range and the required safety is ensured by restricting the stresses in concrete and steel to permissible stresses obtained by applying suitable FOS to the characteristic strength of the materials. The resulting permissible or working stress or allowable stress under service load will be well within the linear elastic range of materials. All the tensile stresses are taken up by the reinforcement and none by concrete except as otherwise specifically permitted. The stress-strain relationship of steel & concrete under working loads is a straight line. The modular ratio 'm' has a value of $\frac{280}{3\sigma_{cbc}}$, where σ_{cbc} is the allowable permissible stress due to bending in compressed expressed as N/mm^2. The allowable stress in steel is denoted σ_{st} expressed as N/mm^2

8) STRUT AND TIE BEAM

- All structures have forces acting on them such as tensile, compressive and shear forces. The part of structures that has a tensile force acting on it, is called a tie and part that has a compressive force acting on it is called a strut.





- A tie usually prevents outward movement (displacement) while a strut prevent deflection.
- A tie could be a flexible member like cable if it can carry required tension a struct can only be a rigid member capable of carrying compression
- Usually ties will be thinner (lesser c/s area) since it is subjected to tension only. but strut will be heavy compared to a tie.
- In structures ties are usually made of steel (structural steel or cables) while strut can be structural steel or reinforced concrete or even masonry.

1. Properties of RCC

concrete is good in resisting compressive stress but is very weak in resi... tensile stresses. Hence reinforcement (steel) is provided inorder to resist tensile stresses. This composite material of steel and concrete ... called as R.C.C [Reinforced cement concrete] and can resist both compressive as well as tensile forces/stresses.

* It can bear heavier loads.
* Fire and weather resistant.
* It is Ductile and Durable.
* It is having high relative strain and high toleration of tensile strain.
* In response to changing temperatures, thermal compatibility, not causing unacceptable stresess.
* It can be mould into any shape and maintanance cost is low.
* Can be used as precast structural components.
* Less deflection and less skilled labour is required for construction

4. LIMIT STATE METHOD AND THREE BASIC REQUREMENTS

LSD is a design method used in structural Engineering. A limit state is a condition of structure beyond which it no longer fulfils it relevant design criteria. The condition may refer to a degree of loading or other actions on the structure, while the criteria refer to structural integrity, fitness for use, durability or other design requirements.

LSD requires the structure to satisfy two principal criteria:-

1) Ultimate limit state (ULS)
2) Serviceability limit state (SLS)

All engineering design criteria have a common goal that it should ensure functionality of the structure and ensure safety of the structure.

The ULS include limit state of collapse including flexure, compression, shear, bond, torson and tension.

The serviceability limit state include deflection, craking, ~~and~~ vibration, fire resistance, durability etc.

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NOV 2016

1) CLASSIFICATION OF CEMENT

Portland Cement
- → ORDINARY PORTLAND CEMENT
- → EXTRA RAPID HARDENING CEMENT
- → PORTLAND BLAST FURNACE SLAG CEMENT
- → SULPHATE RESISTING PORTLAND CEMENT
- → COLOURED CEMENT
- → RAPID HARDENING CEMENT
- → LOW HEAT PORTLAND CEMENT
- → PORTLAND PUZZOLANA CEMENT
- → WHITE PORTLAND CEMENT

HIGH ALUMINA CEMENT

SUPER SULPHATED CEMENT

NATURAL CEMENT

SPECIAL CEMENT
- → MASONRY CEMENT
- → Expansive cement
- → Trief cement
- → Oil well cement

2) GRADES OF STEEL

Steel reinforcement may be of following types:-
- → a) MILD STEEL BARS
  b) HOT ROLLED MILD STEEL DEFORMED BARS
- → a) Medium tensile steel
  b) Hot rolled medium tensile deformed bars.
- → a) Hot rolled high yield strength deformed bars (HYSD bars)
  b) Cold worked steel high strength deformed bars [Fe 415, Fe 500]
- → a) Hard drawn steel wire fabric
  b) Rolled steel made from structural steel.

3) METHODS OF DESIGN OF RC SECTIONS

A RC structure should be designed so that it fulfills its intended purpose during the intended life time with:-

a) adequate safety in terms of strength and stability

b) adequate serviceability in terms of stiffness and durability.

RC members can be designed by one of the following ~~two~~ three methods:-

1) Working stress method (WSM) / Modular Ratio Method.
2) Ultimate load method (ULM) / The load factor Method
3) The limit state Method (LSM)

WRITE BRIEF NOTE ON THREE METHODS

(9) ALLOWABLE STRESSES ON TIMBER / PERMISSIBLE STRESSES [REFER page 10 of IS S...]

Allowable stresses for timber depend on many factors. The working stresses are based upon the basic stresses and appropriate factor of safety. The basic stresses are obtained by tests on small clear specimens of standard grades in the laboratories for standard condition of service.

- cl 6.2
- cl 6.3

} write down from the IS code IS 883:1994.

f) Restrained slab [Refer page 90 of IS 456:2000] ANNEX D - cl D.1

f) [Table 26, Page 91 of IS 456:2000]
classification of slabs based on edge conditions as per IS code

1) Interior panels
2) One short Edge continuous
3) One long edge discontinuous
4) Two adjascent edge discontinuous.
5) Two short edge discontinuous.
6) Two long edge discontinuous.
7) Three Edge discontinuous.
8) Three edge discontinuous.
9) four edges discontinuous.

f) Effective span in one way slab [cl 22.2 of IS 456:2000 page 34]

2) Water Cement Ratio

Strength of concrete primarily depends upon the strength of cement paste. The strength of cement paste depends upon the dilution of paste ie, the strength of paste increases with cement content and decrease with air and water content. 'Abram's' w/c ratio law states that the strength of concrete is only dependent upon w/c ratio provided that the mix is workable. The relation b/w the w/c ratio and strength is shown in figure. It can be seen lower the w/c used when the concrete is vibrated to achieve higher strength, whereas compariteverly higher w/c ratio is required when concrete is hand compacted. In both cases w/c ratio is below the practical limit the strength of concrete rapidly falls due to introduction of air voids.

The graph showing the relationship b/w the strength & w/c ratio is approximately hyperbolic in shape. sometimes it is difficult to interpolate the intermediate value. so, from geometry it is deduced if the graph is drawn b/w the strength & w/c ratio an approximately linear relationship is obtained.