Construction of

BEAM, COLUMN & SLAB

A Report On

Construction of

Beam, Column & Slab

Prepared for

Dr. Mohammad Shariful Islam
Associate Professor
Department of Civil Engineering
BUET

Mr. Shams Tanvir
Lecturer
Department of Civil Engineering
BUET

Mr. Mohammed Maksimul Islam
Lecturer, Civil Department,**BUET**

Prepared by

A.K.M Niloy Pasha	Student no. 1004136
Raj Roy	Student no. 1004140
Md. Abu Bakar Siddik	Student no. 1004148
Sujan Kumar Das	Student no. 1004154
Sadia Tamanna Khan	Student no. 1004159
Sultan Sarkar	Student no. 1004166
Soumya Shekhor Paul	Student no. 1004170
Tanvir Hasan Turan	Student no. 1004181
Md. Saiful Islam Rony	Student no. 1004185
Shofiq Ahmed	Student no. 1004191
Tariq Mehmood	Student no. 1004198

Forwarding Letter

October 8, 2012
Dr. Mohammad Shariful Islam
Assistant Professor
Department of Civil Engineering
Bangladesh University of Engineering & Technology

Dear Sir,
With all thanks to the Almighty, we would like to express our honor on the fact that we are going to present a report on **"Construction of Beam, Column, Slab etc."** This report highlight on the steps of construction of the main and most important components of framed structure which is beam, column, slab, stair and also imparts knowledge on the precaution and special observations that we have encountered during the research on this topic. We tried our utmost to provide necessary data and relevant discussions and illustrations to make the report informative, interesting and purposeful.

We are very grateful to you for selecting such a basic conceptual topic for the report and would like to thank you for your cordial help while writing the report. Your guidance helped us in preparing the report. We are further grateful to **Mr. Shams Tanvir** and **Mr. Mohammad Maskimul Islam** for their kind ameliorate and moderating us decorously.

In this report we tried our best to focus on the main information related to the topic that we have earned from our field trip and further research and now submitting the summary to acquaint you with it. We humbly apologize for all unwilling mistakes which may disturb you while reading the report. We hope that you will consider our limitations of time and information resources.

Obediently yours,
A.K.M Niloy Pasha (1004136)
Raj Roy (1004140)
Md. Abu Bakar Siddik (1004148)
Sujan Kumar Das (1004154)
Sadia Tamanna Khan (1004159)
Sultan Sarkar (1004166)
Soumya Shekhor Paul (1004170)
Tanvir Hasan Turan (1004181)
Md. Saiful Islam Rony (1004185)
Shofiq Ahmed (1004191)
Tariq Mehmood (1004198)
Department of Civil Engineering, BUET. Level-2/ Term-1.

Table of Contents

List of Illustration

Summary

The main and basic components of a framed structure are beam, column & slab. These components are like skeleton of a building. The load transfer principle & relation between these components have made possible to build high rising magnificent mega structures. The loads (gravity, dead or live) are first imparted upon the Slab which is a horizontal load transmitting plate. Then this load is transferred to the beam which is a horizontal component. Column is the main load transferring component of a building. It transmits the load (gravity, dead or live) imposed upon it to the foundation which is the root of the structure. The construction of beam, column, slab & stair follows a systematic way. During the procedure the quality control of the materials used should be kept under control. Shaping the reinforcement, even overlapping their joints, addition of tie bars or stirrups, formwork or shuttering, concrete casting, removal of shuttering and curing are all the steps which should be followed strictly as these are necessary to build a strong and durable building. The engineers present at the site take care of all these procedures. The verticality of the column or the sagness of the beam and slab may be dangerous for the lasting of the building. The total load imposed on the beam, column & slab is carefully measured before the designation. A building is like a human body. If any part of it collapses the whole building will follow the same path. Clear knowledge about the load bearing capacity, load transfer, proper curing will ensure a safe and long lasting building.

1. Introduction

From time immemorial human being craved for a safe place where he can rest & keep him free from all kinds of danger. That is why they made caves, tree houses, stone structure, clay structure, masonry structure and now concrete and steel structure. Civil engineering being the measurement and introducer of civilization it has come a long way.

"The engineer has been, and is, a maker of history"-James Kip Finch. As we know in the past masonry structure, only having the compressive strength providing materials were used in column construction. But with the passage of time more tensile strength providing materials have come to be used in the construction. As a result considering the soil condition people can impose many loads on the structure. The science and its application technology has given us the knowledge to improve the load bearing capacity of these beam, column and slab by introducing RCC and even steel structure. In the present world, countries show their prosperity through their massive structure.

Column, rising from the foundation carries the loads imposed upon it and transfer it to the ground. The beam above the column helps the systematic transfer of loads. Apart from its load transferring point of view it also works as a cantilever. Slab is the plane platform which is directly in contact with the load. Stair is also a kind of slab. This can be regarded as an architectural piece which imparts beauty to the structure.

For the safe and sweet home column, beam, slab needs to be constructed carefully. In this case the knowledge of loading behavior of these components due to different types of loads should be developed.

2. Composite Structure

Composite structures are built with a variety of materials, mixed into a definite proportion in order to provide sufficient durability and strength. In a composite construction, a concrete slab and steel beams act together to resist the load acting on beam and thus the slab acts as a cover plate. Load transferring through these components can be drawn as a flow diagram-

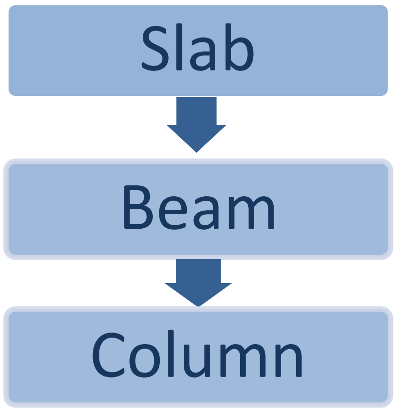


Figure 1: Load transferring flow diagram

3. Materials

Materials needed for constructing reinforcement concrete framed structures are - Fine aggregate, Coarse aggregate, Cement, Water & Reinforcement.

Concrete: A proportioned mixture of coarse aggregate, fine aggregate, cement & water is known as concrete.

Fine aggregate: For the preparation of concrete now-a-days sand are mostly used as fine aggregate. Sand from various sources can be used, but pit sands are of good quality.

Coarse aggregate: As coarse aggregate brick chips, stone chips, gravel, blast furnace slag, shingles can be used.

4. Construction of beam, column & slab

The construction of beam, column & slab follows a common procedure. Each and every steps of this procedure should be maintained with utmost care. The steps of construction are given below-

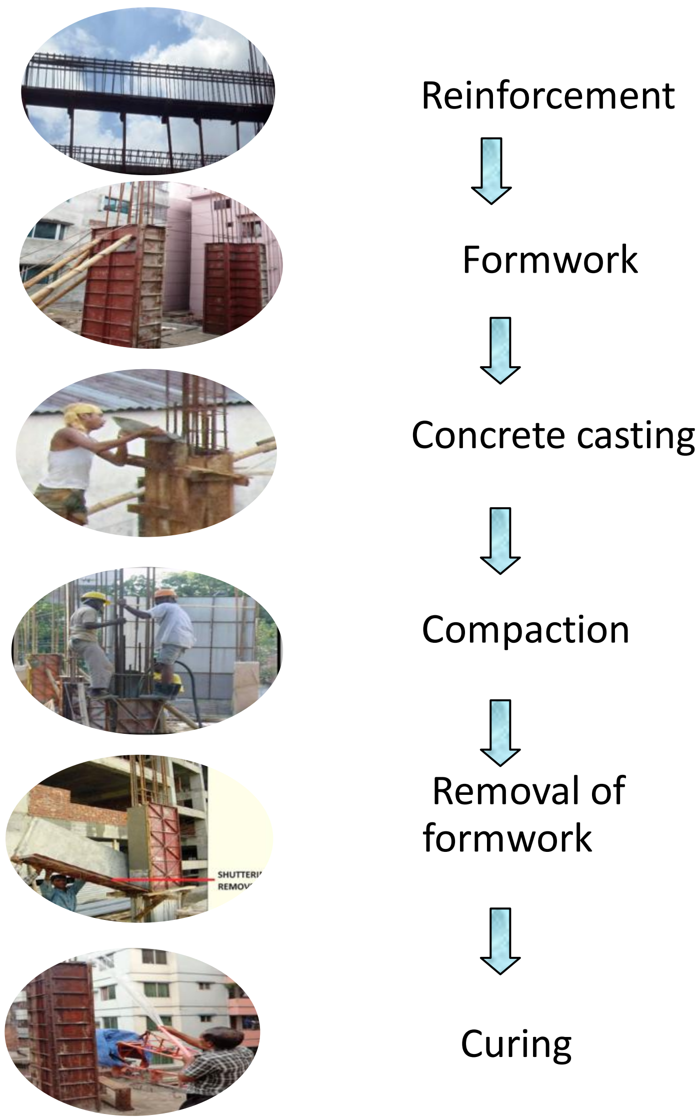


Figure 2: Steps of construction beam, column & slab

5. Column

Columns are vertical members that support loads from the slabs or beams. They can also be defined as members that carry loads in compression. Usually they carry bending moment as well, about one or both axis of cross section. The bending action may produce tensile forces over a part of the cross section.Despite the tensile forces or stresses that may be produced columns are generally referred to as “Compression members”. Because the compression forces or stresses dominate their behavior.

6. Types of Column

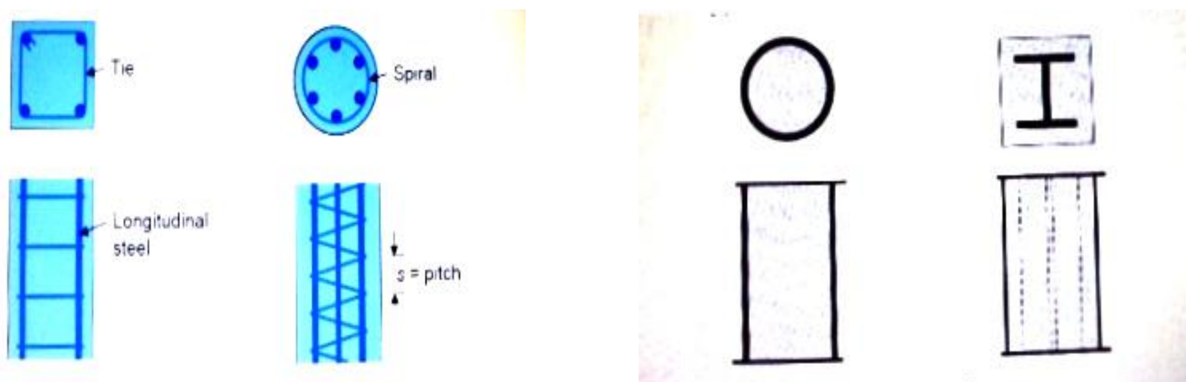
RCC columns are mainly of two types-

i. Short Column: A column is said to be short when its length is such that lateral buckling need not to be considered. Most of the concrete columns fall in these categories. Short column are also divided into three types-

a. Tied columns

b. Spirally reinforced columns

c. Composite columns



Tied Column Spiral Column Composite Column

Figure 3: Different types of Reinforced concrete columns

ii. Slender column: When the length of the column is such that lateral buckling need to be considered, the column is referred to as a slender column.

7. Detailed observation

i. Minimum Number of bars: The minimum numbers of longitudinal bars is-

- four within the rectangular or circular ties
- three within triangular ties
- six for bars enclosed by spirals

ii. Clear distance between bars: The clear distance between the longitudinal bars must not be less than 1.5 times the nominal bar diameter nor 1.5 inch.

iii. Cover: Cover shall be one and a half inch minimum over the primary reinforcement, ties or spirals.

iv. Tie requirements: Ties should be bended at an angle of 45 degree in case of rectangular column. Spiral ties require a certain angle of bending. Bending is necessary so that the ties do not open up quickly on the application of load.

Figure 4: Tie bar

v. Buckling of Columns: Buckling can be defined as the sudden large deformation of the structure due to a slight increase of an existing load under which the structure had exhibited little, if any deformation before the load was increased. It is a mode of failure generally resulting from structural instability due to compressive action on the structural member or element involved.

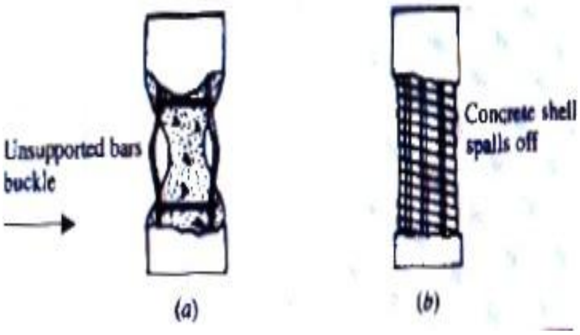


Figure 5: Buckling of Columns

8. Curing

Curing concrete is the term we use for stopping freshly poured concrete from drying out too quickly. The reason that we do this, is because if we let concrete dry out of its own accord:-

- It will not develop the full bond between all of its ingredients.
- It will be weaker and tend to crack more.
- The surface won't be as hard as it could be.

A few methods of curing are given below:

- A simpler way is to just keep water sprayed onto the slab with garden sprinklers or hand held hose pipes. Very wasteful of water and again only done for a short period usually.
- Ponding or flooding is another method for curing slabs. In this process an exterior boundary of about 3 inch is built to hold the water on the slab.
- Some sort of cover that holds and retains sprayed on water, like a sand layer or hessian or gunny bags. Not a good way to do the job, because they have to be kept wet and if they do dry out they actually aid in sucking moisture out of the concrete.


Figure 6: Curing of column

9. Beam

Long horizontal or inclined members with limited width and height are called beams. Their main function is to transfer load from slab to columns.

RCC beams are cast in cement concrete reinforced with steel bars. Beams take up compressive and add rigidity to the structure. Beams generally carry vertical gravitational forces but can also be used to carry horizontal loads (i.e., loads due to an earthquake or wind). The loads carried by a beam are transferred to columns, walls, or girders, which then transfer the force to adjacent structural compression members. In Light frame construction the joists rest on the beam.

10. Types of Beam

Beams are characterized by the shape of their cross-section, their length, and their material. In contemporary construction, beams are typically made of steel, reinforced concrete, or wood.

One of the most common types of steel beam is the **I-beam** or **wide-flange beam** (also known as a "universal beam" or, for stouter sections, a "universal column"). This is commonly used in steel-frame buildings and bridges. Other common beam profiles are the C-channel, the hollow structural section beam, the pipe, and the angle.

Beams are also described by how they are supported. Supports restrict lateral and/or rotational movements so as to satisfy stability conditions as well as to limit the deformations to a certain allowance.

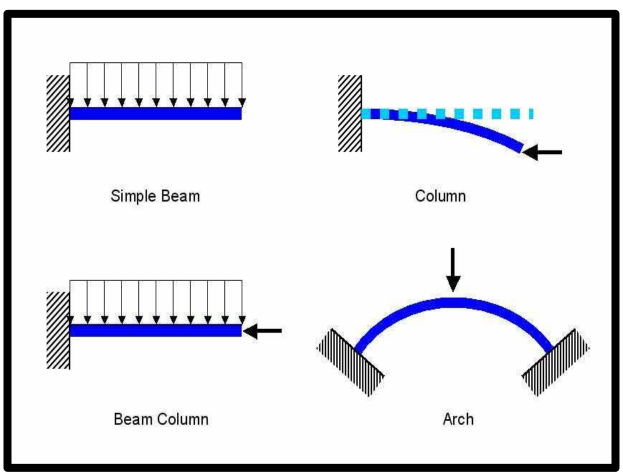


Figure 7: Different types of beams

A **simple beam** is supported by a pin support at one end and a roller support at the other end.

A beam with a laterally and rotationally fixed support at one end with no support at the other end is called a **cantilever beam**.

A beam simply supported at two points and having one end or both ends extended beyond the supports is called an **overhanging beam.**

11. Structural characteristics

Moment of inertia

The moment of inertia of an object about a given axis describes how difficult it is to change its angular motion about that axis. Therefore, it encompasses not just how much mass the object has overall, but how far each bit of mass is from the axis. The farther out the object's mass is, the more rotational inertia the object has, and the more force is required to change its rotation rate.

Stress in beams

Internally, beams experience compressive, tensile and shear stresses as a result of the loads applied to them. Typically, under gravity loads, the original length of the beam is slightly reduced to enclose a smaller radius arc at the top of the beam, resulting in compression, while the same original beam length at the bottom of the beam is slightly stretched to enclose a larger radius arc, and so is under tension. generally halfway between the top and bottom, is the same as the radial arc of bending, and so it is under neither compression nor tension, and defines the neutral axis (dotted line in the beam figure). Above the supports, the beam is exposed to shear stress. There are some reinforced concrete beams in which the concrete is entirely in compression with tensile forces taken by steel tendons. These beams are known as prestressed curved beams and are fabricated to produce a compression more than the expected tension under loading conditions. High strength steel tendons are stretched while the beam is cast over them. Then, when the concrete has cured, the tendons are slowly released and the beam is immediately under eccentric axial loads. This eccentric loading creates an internal moment, and, in turn, increases the moment carrying capacity of the beam. They are commonly used on highway bridges.

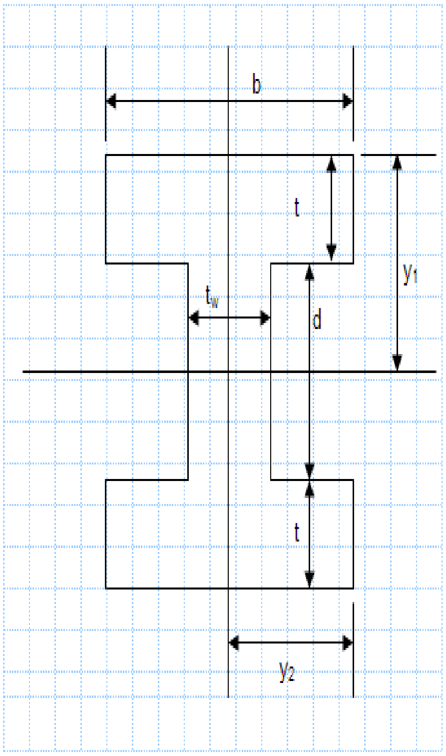


Figure 8: Section of an I-beam

General shapes

Most beams in reinforced concrete buildings have rectangular cross sections, but a more efficient cross section for a beam is an I or H section which is typically seen in steel construction. Because of the parallel-axis theorem and the fact that most of the material is away from the neutral axis, the second moment of area of the beam increases, which in turn increases the stiffness.

An I-beam is only the most efficient shape in one direction of bending: up and down looking at the profile as an I. If the beam is bent side to side, it functions as an H where it is less efficient. The most efficient shape for both directions in 2D is a box (a square shell) however the most efficient shape for bending in any direction is a cylindrical shell or tube. But, for unidirectional bending, the I or wide flange beam is superior.

Efficiency means that for the same cross sectional area (volume of beam per length) subjected to the same loading conditions, the beam deflects less.

Other shapes, like L (angles), C (channels) or tubes, are also used in construction when there are special requirements.

Thin Walled Beams

A thin walled beam is a very useful type of beam (structure). The cross section of thin walled beams is made up from thin panels connected among them to create closed or open cross sections of a beam (structure).

Typical closed sections include round, square, and rectangular tubes. Open sections include I-beams, T-beams, L-beams, and so on. Thin walled beams exist because their bending stiffness per unit cross sectional area is much higher than that for solid cross sections such a rod or bar. In this way, stiff beams can be achieved with minimum weight. Thin walled beams are particularly useful when the material is a composite laminates.

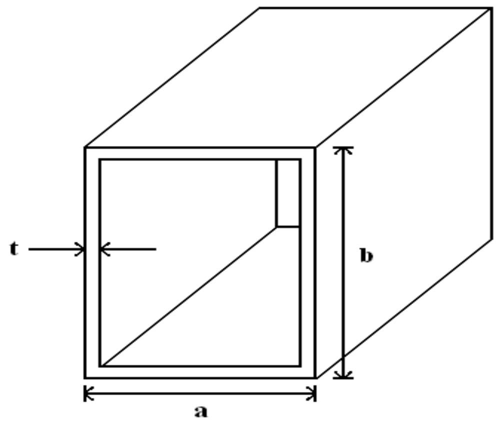


Figure 9: Close thin walled beam

Composite beam construction

Composite action can be achieved with different slab forms.

The behavior of composite beams relates to simply supported beams and in-situ solid concrete slabs. Where other forms are used this may be slightly modified, although the principles and advantages of composite action remain.

Composite beam construction can be achieved with precast concrete slabs but the slabs should be detailed to allow proper shear connection.

The main additional point to be considered in achieving composite action with precast slabs is the need to provide adequate containment for the connectors within the slab. This is normally achieved by leaving pockets or a continuous gap for the connectors. These are in filled with in-situ concrete, providing a bond between the connectors and the precast units. Careful detailing is needed to ensure that this bond is achieved and that there is adequate bearing for the precast slab. The precast slab construction must be carefully detailed to ensure that it can make an effective contribution to the composite beam action.

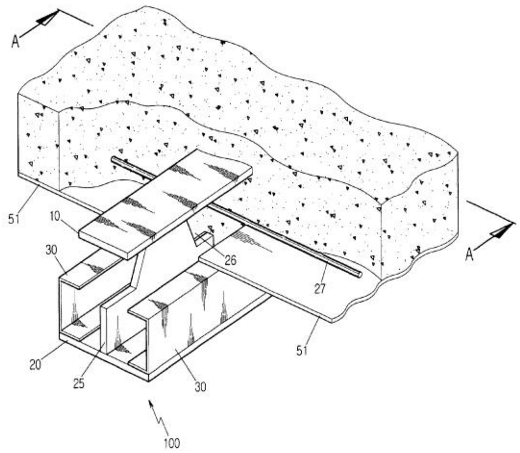


Figure 10: Steel Composite beam **Figure 11:** Composite beam construction

It is clearly necessary that the precast units are capable of providing the compressive force along the length of the composite beam. Since the units are laid individually, continuity can only be ensured by the use of an in-situ topping. Some types of unit, such as those with voids, may not be suitable since the longitudinal compression developed in the concrete slab cannot be transferred through the voids.

Composite beam construction with composite floor slabs is very common, and simply requires that the shear connectors are fixed on site.

The design of the composite beam is largely unaffected, although it may be difficult to accommodate sufficient shear connectors. These can only be fitted where the profiled sheet is in contact with the steel beam that is in the troughs of the profile.

Where this applies, the interaction between the slab and steel beam is partial. The bending strength of the composite beam must therefore be reduced in proportion to the number of connectors which have been omitted.

12. Special observations

i. Distance between the stirrups: The stirrups are usually at close distance to each other at the joint where much shear occurs and which is the critical point for any construction. And the stirrups are at a large distance at the center where maximum bending moment occurs.

Figure 12: Distance between the Stirrups in simply supported beam

ii. Overlapping of Reinforcements: The joints of beam and column are very critical zones. The stirrups of the beam are close in this region. Again the overlapping of the reinforcements of the beams should be kept in mind. The overlapping must be avoided at the joint area. Rather this should be in the mid span of the beam.

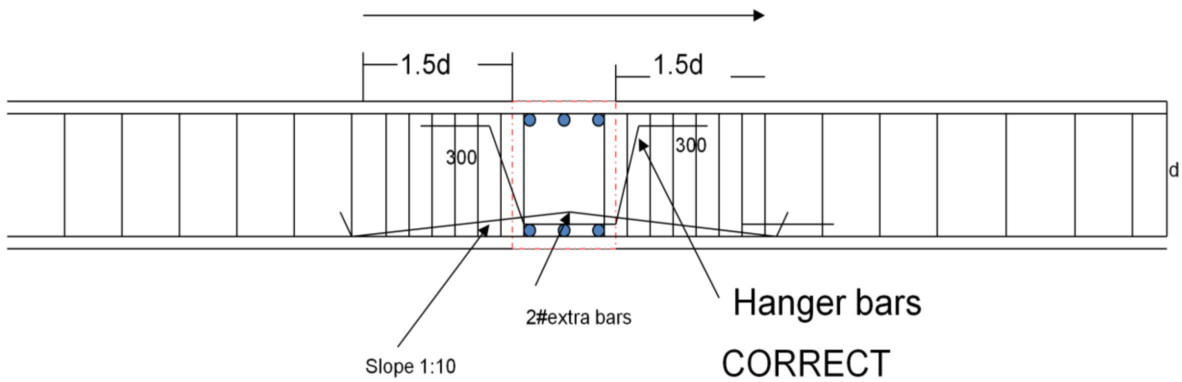


Figure 13: Overlapping of reinforcement & short distance of stirrups at joint

In case of cantilever beam an extra reinforcement should be provided at the joint of the beam which projected from column.

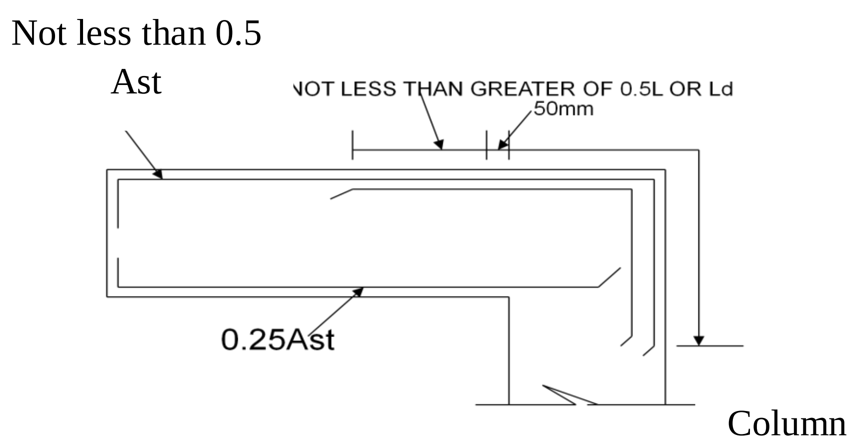


Figure 14: Cantilever beam joint

iii. Bending of stirrups: Stirrups should be bended at an angle of 90 degree.

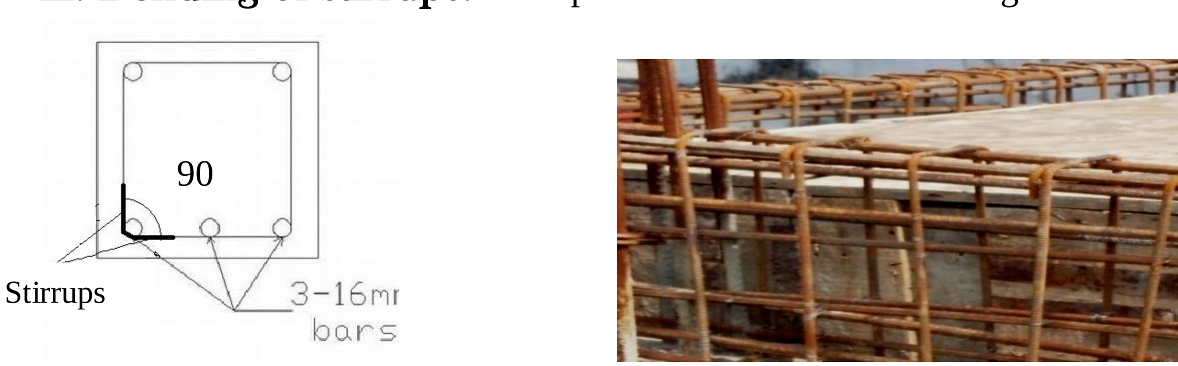


Figure 15: Hooking or bending of stirrups

13. Slab

A Reinforced Concrete Slab is the one of the most important component in a building. It is a structural element of modern buildings. Slabs are supported on Columns and Beams. Slabs are horizontal elements in building floors and roofs. They may carry gravity as well as lateral loads. The depth of the slab is usually very small relatively to its length & width.

In reinforced concrete construction slabs are used to provide flat useful surfaces. A reinforced concrete slab is a broad, flat plate, usually horizontal, with top and bottom surfaces parallel or nearly so. It may be supported by reinforced concrete beams (and is usually cast monolithically with such beams), by masonry or reinforced concrete walls, by structural steel members, directly by columns, or continuously by the ground.

So a slab is nothing but a shallow, reinforced-concrete structural member that is very wide compared with depth. slabs are used for floors, roofs, and bridge decks. If they are cast integrally with beams or girders, they may be considered the top flange of those members and act with them as a T beam.

14. Different types of Slabs

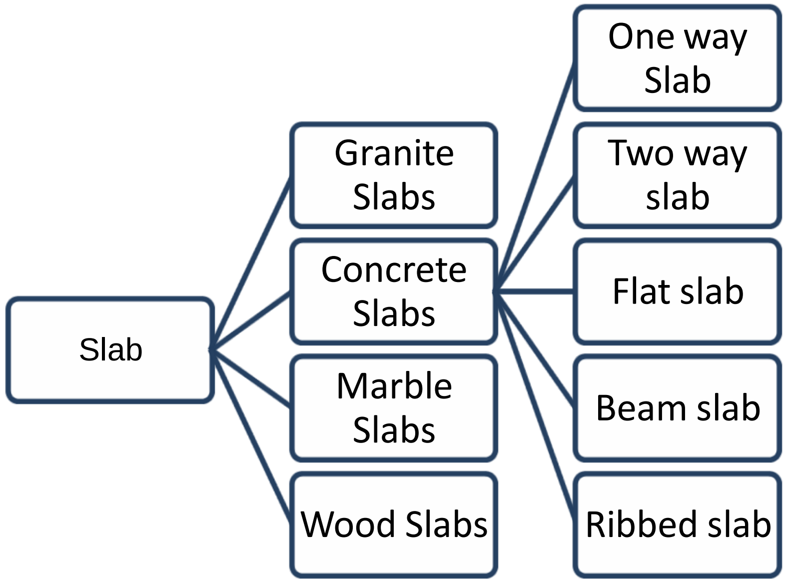


Figure 16: Different types of Slabs

Granite Slab

Granite slabs are simply slabs made out of granite, whether it's natural or synthetic. People who use granite slabs are generally no-nonsense people who have a penchant for simple elegance. Granite slabs give off an elegant vibe that makes them great materials for flooring. Not just that, granite slabs is also very durable and long-lasting.

Marble Slab

Pure marble is beautiful and marble slabs give a outlook of extravagant beauty and aesthesis .Marble slabs are very costly, that's why it gives an aristocratic look. On the contrary, marble slabs are also very hard and therefore very durable. They do not crack easily, even after countless earthquakes.

Wooden Slab

Wooden slabs are rarely seen in the flooring of skyscrapers or any other big buildings, but they're relatively common in the domestic setting (i.e. the home). Wooden slabs generally speak of a love for the simple things in life. However, wooden slabs are also quite hard to maintain, so whoever chooses them over the other materials probably has a lot of patience.

Concrete slab

Concrete slab is one of the most important components in a building. It is a structural component of modern buildings. Concrete slabs can be made to look elegant and austere in a sleek industrial manner. Most significant thing about concrete slabs is that they are great materials for foundations.

Various types of Concrete slabs:

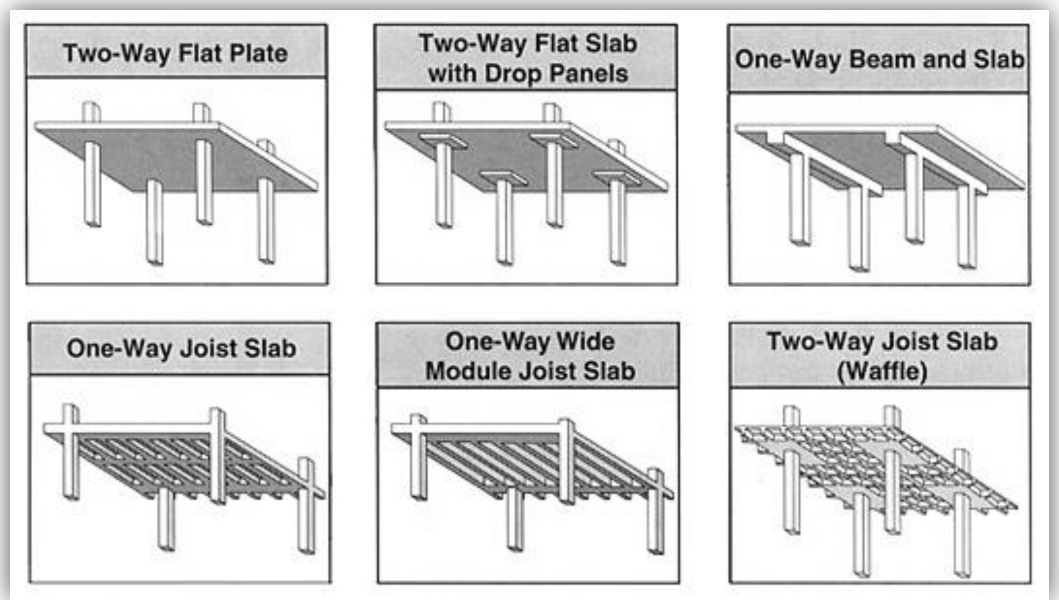


Figure 17: Various types of slab

One way slab

A concrete slab in which the reinforcing steel runs perpendicular to the supporting beams, that is, one way. One way slabs are designed to transfer their loads to only two opposite support walls. One way slabs bend in one direction and load is distributed in one direction only.

Figure 18: RCC slab

Two way slab

Two-way slabs are rectangular reinforced-concrete slabs that are supported on all sides. The reinforcement is placed perpendicular to the sides. Two way slabs are designed to transfer their loads to all the four support walls. A two way slab, have it structural strength in two directions. The load is distributed in all four sides.

Flat Slab

A flat slab is a flat section of concrete. Flat slabs are classically used in foundations, although they can also be used in the construction of roadways, paths, and other structures. Flat plates are the most common type of two-way slab system. It is commonly used in multi-story construction such as hotels, hospitals, offices and apartment buildings.

Advantages

Advantages of slabs are given below:

• Easy formwork
• Simple bar placement
• Low floor-to-floor heights

15. Beam Slab

These slabs are rolled to any required thickness, according to the desired width across the middle of the intended beam; the thinner the slab, the wider or higher is the beam.For small slabs, a bar may be rolled to a sufficient length to make several slabs, the bar being afterwards cut with shears into the desired number of pieces.

Large slabs are conveniently made singly, the width of each one being the width of the widest part of the slab when finished. After the component piece is rolled to a proper thickness, the desired shape is next marked upon the side, and the superfluous pieces cut off with a broad steam-hammer chisel. During the trimming of a beam slab, or other similar piece of work, a thick plate of copper or soft iron is fixed to the anvil face, to prevent the chisel edge touching the anvil. The mode of fixing or shaping the fender-plate to a small anvil or anvil-block consists in heating the plate to redness and fixing it between the hammer and anvil; and, while fixed, the portions that extend from the anvil are driven down with sledge-hammers. For such fender-plates, a thick iron plate is preferable to copper, although copper is much used.

16. Joist/Ribbed Slab

Rib slab is a reinforced-concrete floor and roof construction employing a square grid of deep ribs with coffers in the interstices.

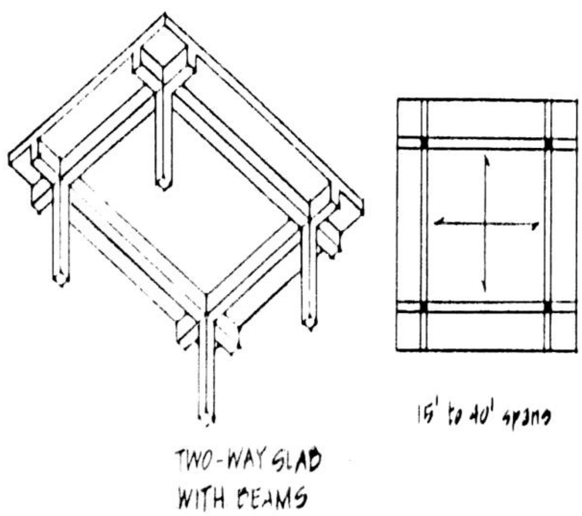


Figure 19: Two way slab **Figure 20:** Joist/ ribbed slab

Advantages:

1. Longer spans with heavy loads (12-15m)
2. Reduction in dead loads due to voids
3. Electrical and mechanical installations can be placed between voids
4. Good resistance to vibrations.

Disadvantages:

1,Only moderate and uniformly distributed load can be accommodated.

17. Special observation of slab construction

i. Cover: Cover should be maintained in placing the reinforcements. Cover can be of many shapes, such as- cubic, cylindrical.

Figure 21: (a) Cube C.C block (b) Cylindrical C.C Block

ii. Different types of Re-bars: Different types of reinforcements are used in slab. Tension bars are located at the bottom for positive moments & at the top for negative moment. Temperature bars are used to avoid shrinkage or expansion due to temperature change.

Cranked bars are used at the outer edge of the slab, near the joint. These bars are used to avoid negative moment of the slab at the edge. Cranked bars are at an angle of 135 degree.

iii. Stair: Stair is also a kind of slab. It is also an architectural piece of the building.

- The reinforcements are bended at an angle 135 degree.
- All rises in the same flight must be equal
- All treads in the same flight must be equal
- Rise+ Tread should be equal to at least 17 inch

Figure 22: RCC of stair (front & side view)

18. Details of Constructional Steps

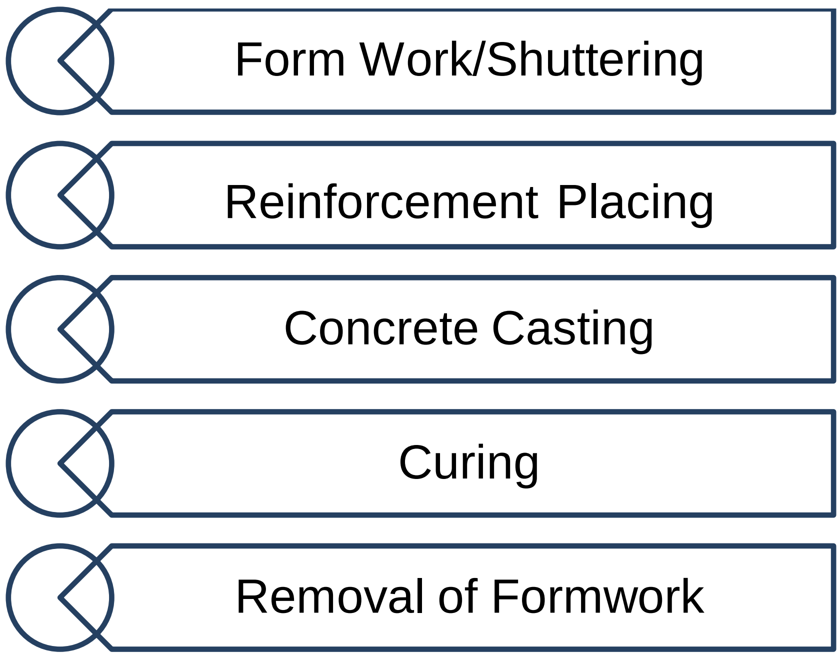


Figure 23: Steps of Construction of Beam, Column & Slab

19. Form Work/Shuttering

Centering, shuttering or formwork is a sort of construction provided for lying concrete to require a perfect horizontal slab. For slab, a good formwork should satisfy the following requirements-

- It should be strong enough to withstand all types of dead and live loads.
- It should be rigidly constructed and efficiently propped and braced so as to retain its shape without any deflections.
- The joint in the formwork should be tight against leakage of cement grout.
- The material of the formwork should be cheap, easily available and should be suitable for re-use several times.
- The formwork should be set accurately to the desired line and levels and should have plane surfaces.
- The formwork should be as light as possible.
- The formwork should rest on firm base.

Types of Formwork

According to the materials used-

1. Timber formwork
2. Plywood formwork
3. Steel formwork

Preparation of shutter

Shuttering can be made up of timber planks, or it may be in the form of panel units made either by fixing plywood to timber frames or by welding steel plates to angle framing. In any case, the shuttering should be constructed in such a manner that the joints should be tight against leakage of cement grout.

Steel props are placed vertically at a certain intervals (here 3′–6″). There is holder/notch at the top of each prop and 3″×3″ hollows can be placed on them. A horizontal frame constituting of squares are formed in this way.

Perfect sized square shaped steel shutters are joined with the adjacent ones by shutter bolt/clips and then placed on the frame made of hollow. At first the height of the slab is determined by measuring from the immediate bottom floor. Then the measured height acts as a temporary bench mark. A level machine is used to level the whole slab.

The shutters are cleaned with the help of a cup wire brush. The shutters are swept with Form Oil. Here a mixture of mobil and diesel is used as Form Oil. Here mobil is the main component and is more in amount. On the other hand, diesel is used to dilute mobil.

After casting and curing when the shutters are removed, some concrete may stick to them and come out from slab. This is never desired. But, if oil is used in between concrete and shuttering they will never get stuck.

Form Oil is harmful to rod. So, it should not be used so much so that it can come in contact with bottom layer rod.

Figure 24: Shuttering

20. Reinforcement placing

Slab takes all live and dead loads, it has a tendency to bend. If slab is made only by concrete it will fail to retain self weight of concrete. So reinforcing bars must be provided. This can be better understood as skeleton in human body. We use mild steel bar as reinforcement bar. Normally No. #3, 4, 5 or above bars are used in our country No.#5 bar is most used that we have found it in our visited sites.

The maximum bending moment for which the slab should be designed varies with the nature of the slab (whether one way reinforced two way reinforced) loading conditions, the number of spans and the end conditions of the slab. The bending moment which causes tension at the bottom of the slab, usually near centre of the span is called positive or sagging bending moment and the bending moment which causes tension at top of the slab, which usually over the support is called negative or hogging bending moment. Thus for positive bending moment, the main reinforcements are placed near the bottom face of the slab while for negative bending moment, the reinforcement are placed near the top of the slab.

Figure 25: Reinforcement placing

We know that corrosion is one of the causes of failure of structure. To prevent the corrosion we have to remain clear cover. The minimum clear cover for slab is 0.75 or 1 in . According to surrounding condition and probability of dampness it may be more then minimum requirement. This clear cover is maintained by using C.C. block. Many sizes of C.C. block are being used now-a-days. It`s may be cube or cylindrical in shape.

First bottom layer bars are placed then crank bars are placed between two bottom layer bars but it. Extra bars are provided near the support with the vertical alignment of bottom layer bars.

After placing reinforcement polythene sheets are provided to make the concrete leak proof. Simultaneously electric utility lines are being placed.

Binding of reinforcement:

1. GI wire
2. Welding

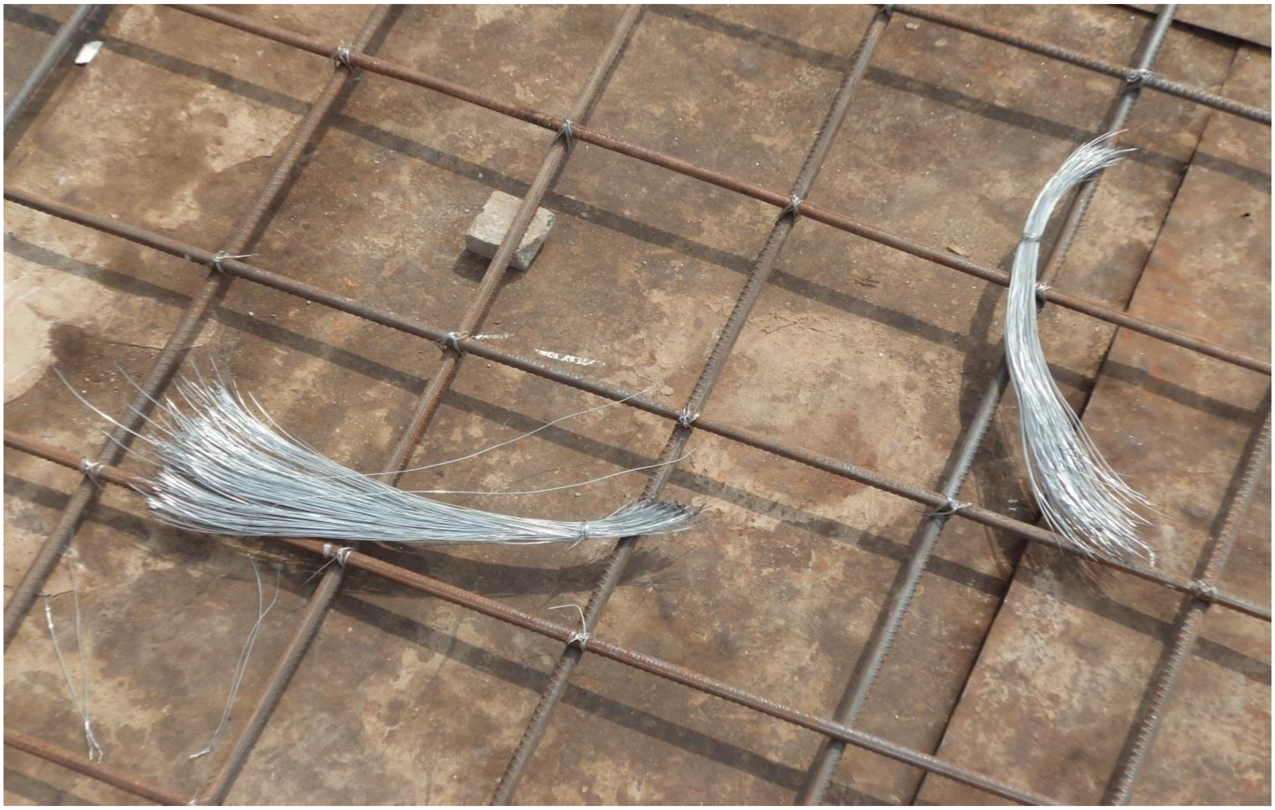


Figure 26: GL wire using in slab reinforcement binding

We have to bind the reinforcement. Then the reinforcement will act as a body. Otherwise the reinforcement would bend due to the load of concrete and the clear cover will not be uniform. There are two ways of binding the reinforcement. One can weld the reinforcement. This is done in the important portions of the slab such as the joints. In the mega structures slab reinforcements are welded sincerely. If we not do so then the structure would become weak.

21. Concrete Casting

Concrete is the most important material for slab construction. Concrete is a mixture of water, cement, fine aggregate and coarse aggregate. Concrete is mainly used as a compression bearing material. To get a strong, solid slab we have to ensure that the concrete we are using is of good quality and good quality concrete can be

Again we have to also ensure that concrete has been prepared by mixing all the materials with proper proportion and condition. Materials should be mixed thoroughly so that we would get a concrete mixture which is of uniform density. Good quality concrete is not enough for having a hardened concrete of greater strength. We have to ensure that concrete is being casted properly. If the concrete is not casted properly then we would not get desired strength concrete.

Figure 27: Concrete casting

Concrete Mixing:

Concrete mixing can be done in many ways. Mostly the under mentioned methods are applied-

1. Mixing in situ
2. Ready mix concrete

The site we visited uses the ready mix concrete. Generally ready mix concrete is of good quality because the materials are mixed according to the mix proportion. Ready mix concrete is also used in the congested sites.

Components of concrete mixture:

The main components of concrete mixture are fine aggregate, coarse aggregate, water and cement. These components all together provide compressive strength to the structure.

FA: Sylhet sand (FM > 2.5)

CA: Stone chips ,brick chips, gravel etc.

Cement: FA: CA →1: $1\frac{1}{2}$: 3

Concrete strength: Minimum 3500 psi.

22. Compaction of concrete

Minimizing void is very important to gain estimated strength. So to minimize void compaction is obligatory. If we do not provide proper compaction then the concrete will be of lesser strength. Compaction can be done in different ways. Such as:

1. Hand Compaction
2. Vibrator

Concrete is thrown from above on the rods. This operation should never be done from more than 1m height; otherwise, segregation of concrete will take place.

In our site electric vibrator was used. The concrete is thoroughly distributed, freed from voids and honey comb by using a vibrator vertically at each 1′ distance.

Figure 28: Compaction using vibrator

Leveling of concrete:

Concrete is leveled using a ‘Patta’. Is has two sides. A level staff is held on a trowel on one side and by a leveling machine the required height is given. The other side is automatically leveled. Now it’s checked whether, all the points are on the same horizontal level. If a point is lower, some concrete is added. If a point is higher, some concrete is removed. Where the level is exact it is cross marked. Further casting is done with reference to it.

Curing:

Curing of concrete is one of the essential requirements of the process of concreting. Curing is the process of keeping the set concrete continuously; damp for some days in order to enable gain more strength. The strength of concrete increase more rapidly in the first few days after setting and after the rate of increase in strength goes on retarding.

In general, slab is a flat horizontal member, so its curing process is not so complicated. For curing of slab impounding method is applied widely. All the sites we have visited impounding method is found to be used for curing.

Now-a-days engineers design the slabs for many building services such as electric wire line, plumbing line etc. The top floor slab is designed to resist the dampness of rainfall and for heat insulation.

23. Removal of formwork

After 14 days of concrete casting the formwork of slab is removed. That’s the end of slab construction.

Figure 29: Removal of form work

24. Simple connections in different parts of building

Simple connections are defined as joints between members that have not been designed with the intention that they transmit significant moments. Their purpose is to transfer load from the supported member into the supporting member in such a way that essentially only direct forces are involved, e.g. vertical shear in a beam to column or beam to beam connection, axial tension or compression in a lattice girder chord splice, column base or column splice connection. They may, therefore, only be used in situations where sufficient bracing is present that, when the joints are assumed to function as pins, adequate overall structural resistance is present. Popular arrangements include lattice girders and bracing systems or connections between beams and columns in rectangular frames in which lateral loadings are resisted by stiff systems of shear walls, cores or braced bays.

When considering the design of the frame to withstand gravity loading, the assumption of pin connections makes the overall structural analysis particularly straightforward, since loads can be traced from floors into beams and into columns using a simple statically process. Simple joints also lead to easier fabrication and erection, therefore, likely to produce the most cost-effective steel frames. Taking the example of a beam to column connection, the simple joint must:

- transfer the beam reaction into the column in shear
- have sufficient flexibility not to transfer other than small moments into the column, e.g. due to some small eccentricity in the lines of force transfer
- Possess sufficient rotation capacity to permit the beam to develop its "simple" deflected shape.

1.BEAM-TO-BEAM CONNECTIONS

Floor decks in buildings are usually supported by means of grids of secondary beams and main girders simply connected to each other.

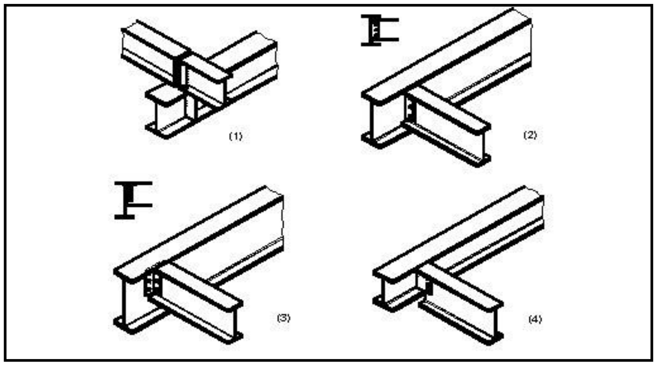


Figure 30: Simple beam to beam

The beam end may be coped removing part of one or both flanges, when the beam and girder flanges meet at the same level. The beam is thus locally weakened. For web cleated connections, it is good practice to place the angles as close as possible to the upper flange of the girder in order to minimize cracking of the concrete floor slab due to the beam rotation.

2. BEAM-TO-COLUMN CONNECTIONS

As for beam-to-beam connections, the connectors should be able to resist the beam reactions and the relevant moment due to the eccentricity of the force to the centerline of the connecting material. Since this eccentricity is relatively small the column bending moment for such a connection is much smaller than from a moment connection.

It is also necessary to ensure - usually by means of appropriate detailing - that the connection will function in the manner intended, i.e. will not be too stiff and will possess adequate rotation capacity. This may be achieved by ensuring that strength is governed by a ductile mode of failure.

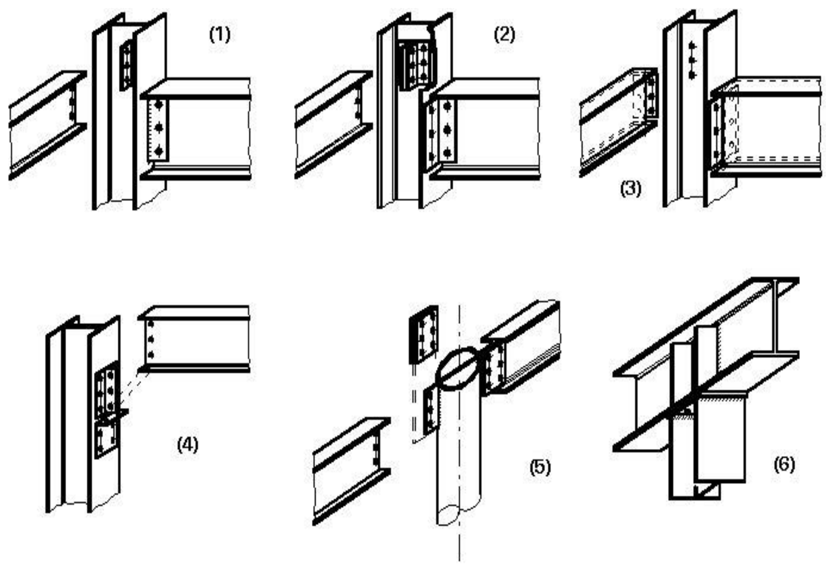


Figure 31: Simple beam to column connection

3. COLUMN SPLICES

In simple frames columns are predominantly stressed in compression. In theory no splice connection is required, since the compression force is transmittable by direct bearing. Due to the presence of geometric imperfections (lack of straightness of the column) as well as of unavoidable eccentricities, and to the fact that even carefully machined surfaces will never assure full contact, connections have to be provided. They should be designed to resist the internal forces (other than compression) determined in the column at the point where they are located.

The location of the splice should be selected so that any adverse effect on column stability is avoided, i.e. the distance of the connection from the floor level should be kept as low as possible

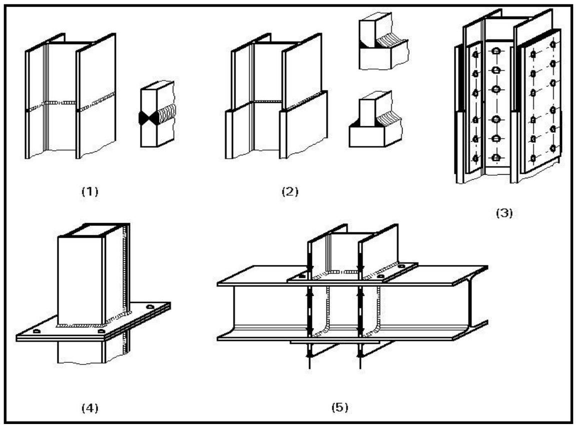


Figure 32: Column splices

More significant bending resistance may be required in splices when columns are subject to primary moments, as in a frame model assuming hinges at, or outside, the column outer face. In addition, in columns acting as chords of cantilever bracing trusses, tensile forces may arise (uplift) some loading conditions, which must be transmitted by splices.

4. BEAM-TO-CONCRETE WALL CONNECTIONS

In high-rise buildings it may be convenient to combine the structure resisting gravity loads with a concrete core resisting horizontal forces. Attaching the working frame to a concrete core is mainly a practical problem, since the two systems are built with dimensional tolerances of a different order of magnitude. Special care should be taken to account for the relative sequence of erection of the concrete and steel system, the method of construction of the core (on which concrete tolerances also depend), as well as the feasibility of compensating for misalignments.

Conclusion

The construction of beam, column & slab is a very significant task. In framed structures beam and column provide the skeleton of the structure. If they are not built with proper care, consideration and knowledge then the building is sure to collapse. In this report the construction difficulties of beam, column, slab etc are discussed. Beam to beam joint, beam to column joint are also of much significance as these are the most vulnerable place of the whole construction work. Column, rising from the foundation carries the loads imposed upon it and transfer it to the ground. The beam above the column helps the systematic transfer of loads. Apart from its load transferring point of view it also works as a cantilever. Slab is the plane platform which is directly in contact with the load. Stair is also a kind of slab. This can be regarded as an architectural piece which imparts beauty to the structure. Shaping the reinforcement, even overlapping their joints, addition of tie bars or stirrups, formwork or shuttering, concrete casting, removal of shuttering and curing are all the steps which should be followed strictly as these are necessary to build a strong and durable building. The engineers present at the site take care of all these procedures. The verticality of the column or the sagness of the beam and slab may be dangerous for the lasting of the building. The total load imposed on the beam, column & slab is carefully measured before the designation. A building is like a human body. Clear knowledge about the load bearing capacity, load transfer, proper curing will ensure a safe and long lasting building. This report is sure to impart knowledge in this regard.

Appendix

Abbreviations

RCC- Reinforced Cement Concrete

CC- Clear Cover

ACI- American Concrete Institute

Re-bar- Reinforcement bar

Glossary

Monolithic structure- When beam and slab are casted at the same time. After the reinforcement addition and shuttering of the beam slab reinforcements are prepared. Concrete casting of these components follow the same order.

Ponding- A method of curing in which a boundary is formed by cement paste to hold water on the slab. The height of the boundary is usually three inch. This is a common method of curing of concrete slab.

Anvil- An anvil is a basic tool, a block with a hard surface on which another object is struck. The inertia of the anvil allows the energy of the striking tool to be transferred to the work piece. In most cases the anvil is used as a forging tool. Before the advent of modern welding technology, it was a primary tool of metal workers.

Splice- Splice may be referred to as connection of two or more pieces of linear material.

Lattice girder- A lattice girder is a girder where the flanges are connected by a lattice web. This type of design has been supplanted in modern construction with welded or bolted plate girders, which use more material but have lower fabrication and maintenance costs. The lattice girder was used prior to the development of larger rolled steel plates.

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