PART - A

1. Explain briefly the disuniting of structures? [May/June 2012][Nov/Dec 2013]

In prefabrication many elements of prefabricated, are assembled or united or joined to form a single structures.

The problem in prefabrication is the transportation. To avoid this problem of transportation, the structure is disunited or separated into smaller or elements, so that the transportation becomes very easy.

2. Write the advantages of disuniting structures? [Nov/Dec 2012]

- The number of joints is reduced.
- Failure at joints is minimum.
- This disuniting method is suitable for site prefabrication.
- Transportation cost for many elements to the site is reduced.

3. Write the disadvantages of disuniting of structure?

- The lifting or hoisting of the entire frame is more difficult.
- Transportation of the frame from the plant is difficult.
- Transport cost is high for the transport of entire frame.
- The stress distribution during lifting is a problem.

4. How can we classify the prefabrication principles?

Prefabricates are classified as homogeneous and composite based on the number of different material used in fabrication.

5. Mention the design of c/s in prefabrication?

The c/s of precast reinforced concrete structure is normally having the following.

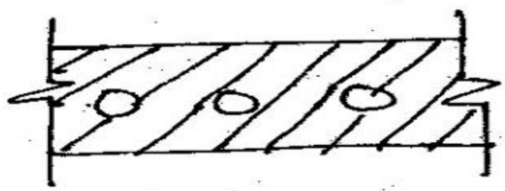
- Tee section
- I section
- U or v section

6. Write the classification of homogeneous prefabrication?

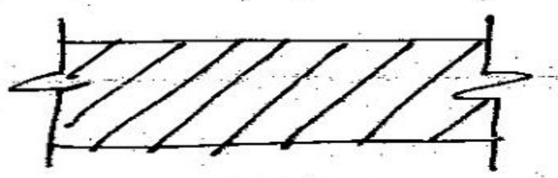
The homogeneous unit may be classified into 3 types.

- Hollow
- Solid
- Ribbed

Hollow



Solid



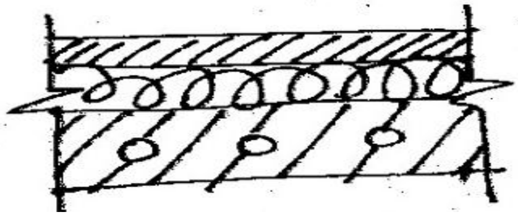
Ribbed

7. Write the classification of composite prefabrication?

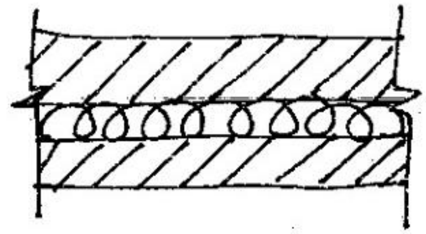
The composite unit may be classified into 3 types.

- Cored
- Solid
- Ribbed

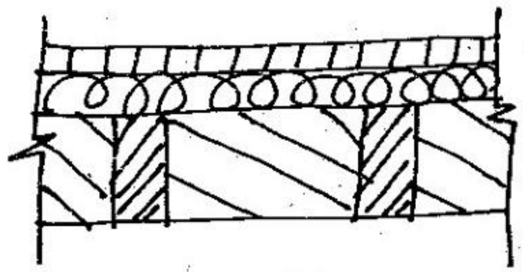
Cored



Solid



Ribbed



8. How does the material used in construction affect the design of the element? [May/June 2009]

The materials for the construction are classified as homogeneous and composite based on the number of different material used in prefabrication.

9. Explain joint deformation? [May/June 2009] [May/June 2012]

Various structural elements are made in the plant or prefabricated when these elements in their site there may be joint deformation to take it workout deformation.

10. Mention some important requirements of the joint flexibility? [May/June 2013]

- The construction of joint should be easy.
- The joint should require little material.
- Joint should not consume more labour.
- Less labour is to be required.
- The cost should be minimum.

11. Distinguish between rigid joint and hinged joint with reference to prefabricated construction? [Apr/May 2013]

The rigid joints are of adequate (sufficient) strength, in addition to bearing of tensile, compressive and shear force and for resisting bending moment.

The hinge joint is those which can transmit force passing through the hinge itself allow sudden motion and rotation.

12. Write the system consisting of linear member disunited at joint?

Disunity at joint gives the linear member, this means a great advantages and facility from the view point of both manufacture and assembly. Using this system, auxiliary scaffolding is not necessary and the hoisting process is as a rule very simple.

13. Explain joint flexibility. [Nov/Dec 2013][May/June 2013]

A joint that holds two parts together so that one can swing relative to the other is called joint flexibility.

14. List the disadvantages of precast construction. [Apr/May 2011]

- Very heavy members
- Camber in beams and slabs
- Very small margin for error
- Connections may be difficult
- Somewhat limited building design flexibility

PART - B

1. Explain the steps involved in the process of disunity of prefabricated structures? (May / June – 2013) (May / June – 2013) (Nov/ Dec – 2013)

In prefabrication many elements of prefabricated are assembled or united or joined to form a single structure.

The problem in prefabrication is the transportation. To avoid in this problem transportation the structure is disunited or separates into smaller elements so that the transportation becomes very easy and in the site they may be united are assembly.

This method of separating into smaller member or element is called disunity structure in prefabrication.

Instead of using the larger member as beam or girder, two or three smaller sections may be used and united together as a single member but the load carrying capacity of a single large member should be equal to sum of load carrying capacity two or three smaller members.

Normally in factories in production is done in a faster rate for many small prefabrication elements. This leads to disunity of the structures into members suitable for plant prefabrication and for shipping. There are 4 methods of disunity structures.

(a) Systems consisting of linear members disunited at joints:

Disunity at joints gives linear members this means a great advantage at facilities in manufacturing and assembling.

Advantages:

- Scaffoldings or auxiliary scaffoldings are not necessary.
- Hoisting or lifting method is very simple.

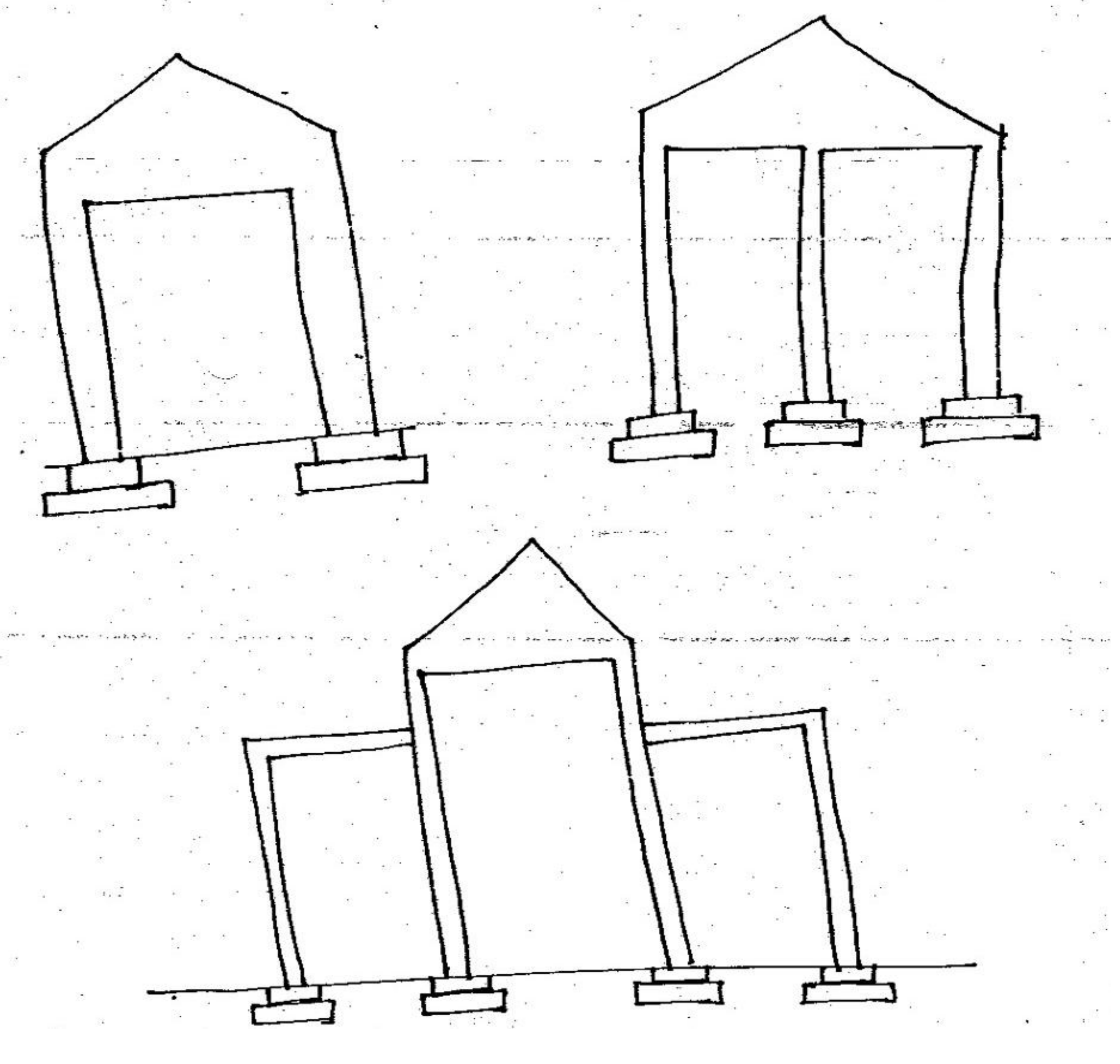
Disadvantages:

The main disadvantages the joints at the corners that is places were the moments are maximum. So the formation of joint is very difficult.

- The quality of concreting should be very high in these precast members.
- The joints must be over dimensioned.
- This makes additional materials to be used for precast members.

This disadvantage is overcome are rectified by the new trend or method of replacing moment resistance joints by hinge like structures etc...

In this method more material is required for beams the complicated construction of rigid corners can be omitted.



(b) System for the prefabrication of disuniting into entire frames:

In this method the entire frames the total structure are disunited or separated.

Advantages:

- The members of joints are reduced.
- Failures of joints are minimum.
- This disunity method is suitable for site prefabrication.
- Transportation cost for many elements to the site is reduced.

Disadvantages:

- The lifting or hoisting of the entire frame is more difficult.
- Transportation of the frame from the plant is difficult.
- Transport cost is high for the transport of entire frame.
- The stress distribution during lifting is a problem.

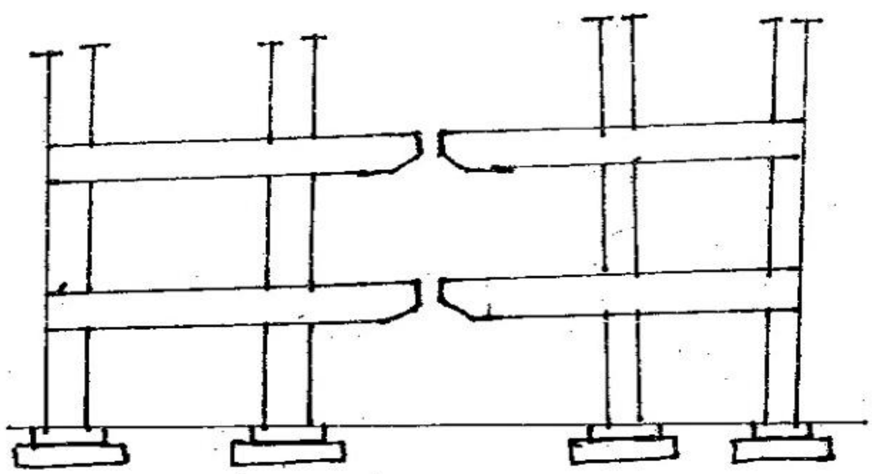
The stress distribution of straight member during lifting is to be determined. The stress distribution arising in frame during their hoisting is statically redundant.

The tilting of the frame from the horizontal into the vertical position lifted at two points two separated acting hoisting machines are the methods of lifting the frame. If these two points are lifted or hoisted at the same time uniformly, the frame will be affected by torsion.

Connecting to suspension points by the balance or a cable rocker makes the frame to be lifted at a single point. In this case also torsion occurs if the rocker is not suspended at exact point.

From this it's clear that hoisting of a frame is more complicated and difficult than hoisting a straight member.

Similarly hoisting of unsymmetrical frames is also very difficult. So this method is advantageous where small member of joints are required and where there is possibility of rapid works.



(c) Straight members disunited at points of minimum moments:

The production and placing of arches is more difficult than the straight members.

Advantages:

- Less material is required and long span structures its economical.
- Arches may be two hinged or three hinged may be fixed at footing and made up with or without ties.

The arches are usually precast assemble in the site. The middle hinge is eliminated after the placing finishing. RF bars for both the members are welded together joint between the members filled with insitu concrete. The structure is transformed to the two hinged arch rigidity is increased. The movements or motion under wind load is reduced. The method is suitable for eliminating all three hinges. In this case a arch fixed at both ends is obtained.

Arches can be precast in vertical and horizontal position. In vertical position the shuttering made up of member or concrete is required having the same curvature of the arch prefabrication is larger. Arches in the horizontal position are more economical.

The construction of arched trusses can be carried out in horizontal position only.

2. Explain the problems involved in design because of joint flexibility. Discuss with regard to various locations. (May/June – 2012) (Nov/Dec – 2013)

There are difficulties and problems if the joints of various elements are not proper. If joints not strong then the failure will occur in the structure. It is important to solve the problems n design and construction structure by assembling (jointing) many precast members.

i. Any joint should be easy.
ii. Smaller in accuracies will not influence any problem.
iii. Deviations in joints are also leading to problem in design.
iv. Dimensional tolerances should not cost many changes in the stresses design and stress distribution in the structures.

Important requirement of the joint:

1) The construction of joint should be easy.
2) The joint should require little material.
3) Joint should not consume more labour(less labour is to be required).
4) The cost should be minimum.
5) Greater control informing and construction of joints is necessary.
6) Inspection of joints is always important.
7) The design and construction of the joint should match or harmonize material to use.
8) The properties of steel and timber are different from concrete and RF concrete.
9) So the joints similar to those used in timber and steel construction are generally not suitable.

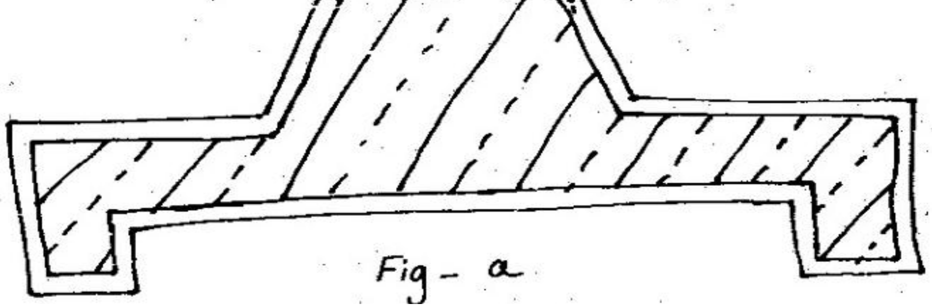


Fig – a

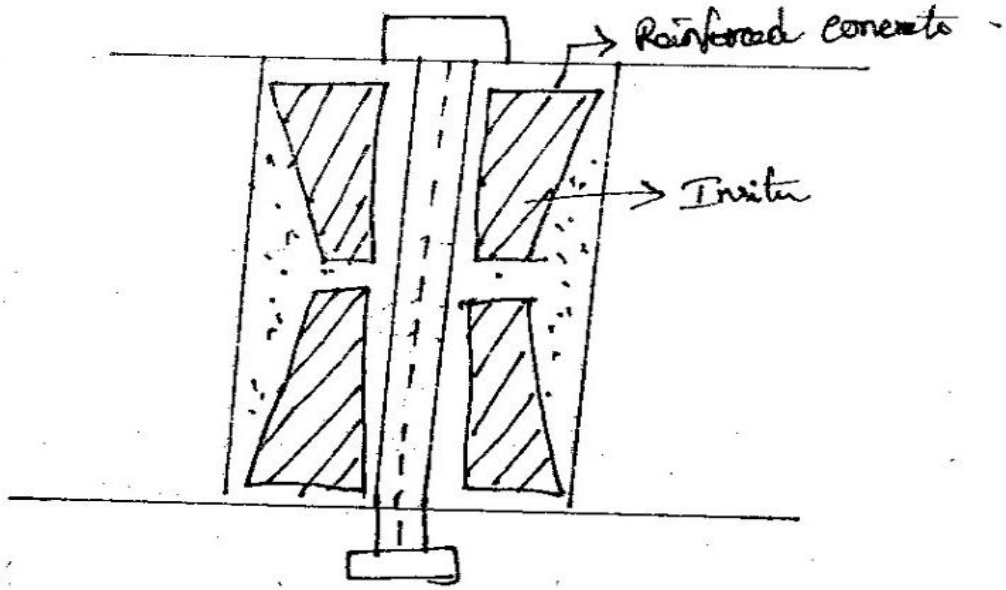


Fig (a) The butt joint was made with splayed table as used in timber construction. This is not suitable if the nature of material is R.C.C.

Fig (b) In pin joints is used which looks like a joint used is steel construction. So this joint is not suitable for the design.

Fig (c) The structural parts of welded to the reinforcement. This is not sufficient for the suitable connection or joint. Two halves of the steel structure forming the main joint should be concreted ends of the jointed members. The slightest rotational displacement is sufficient to fit the teeth of each other and the placing of the pins.

The threaded steave coupling of steel bars is also a problem in design of joints.

An important advantage of steel is that in tensile and compression shear strength differ from only to a small extent. So the joints are relatively simple and easy in steel construction.

In case of joint between statically redundant steel structures which reaches the yield point the redistribution of stresses is advantageous which steel construction the method of joining other than those for R.C.C structure should be used.

Shrinkage when drying and creep in timber after the method of joint to a high degree.

Concrete is also to shrinkage but RF reduces it at certain level. For precast structures the shrinkage occurring before when its place is not important and similarly that take place thereafter is not much. The importance of shrinkage developed in joint fitted to insitu concrete or grout is greater.

Two importance points to be considered are,

1. The plastic construction used for further concreting of joints and the fluid cement mortar cast are pressed into gaps loose.

2. After settling the shrinkage of the insitu concrete and mortar continues with respect to two phases of shrinkage the codes on RCC permit only reduced stresses for a subsequent insitu concrete of a mortar casting. These are determined as a function of width of the joint or the gap to be concreted.

The joint to execute by allowing proper dimensional tolerances due to unfavourable force effect and due to below, the relation displacement of the joint members should be impossible if the dimensional tolerance is ensured.

The length of the section dimensioned the transmission of forces should be as short as possible and exclude any excess permissible stress.

The joints may be

(i) Rigid

(ii) Hinged.

The rigid joints are adequate in addition to bearing of tensile, compressive and shear force and for resisting bending moments. These joints make relative displacement and relative rotation impossible.

The hinge joints are those which can transmit forces passing through the hinge itself allow sudden motion and rotation.

The rigid joints are generally used for joining individual members to another but for rigid joint considerable man power is required. The hinged joints are executed simply and require less time than the rigid joint.

Shod joints are joints used rarely are exceptionally in industrial construction. The shod joints are used for long span only. These are mainly used in bridge or long span bridge.

Depending on the insitu concrete there are two types of joints.

(i) Dry joint:

The dry joint is a joint used for simple placing of two members on each other and connecting them.

When a rigid joint is form is difficult to lengthen the steel bars to be joined by overlapping or by welding them together, when a discontinuity of concrete is avoided by as skilled continuous concreting. This kind of joint which requires not only a casting with cement mortar but also a continuous or subsequent concreting is called a wet joint.

(ii) Wet joint:

Wet joint should comply with the character of the material of the structure to the form. This joint avoids discontinuous between the members structures assembled by using wet joints have a monolithic character.

Structure member produced by planned prefabrication and to be disunited later are usually jointed by dry joints. The advantage of this is the subsequent to the execution of the joint, the structure becomes immediate load bearing.

Wet joints are more adequate to bear the forces and are less sensitive to inaccuracy than by joint.

In steel construction steel shoes and hinges are used when great forces are to be transmitted the hinges of expensive and if possible they may be omitted in this case.

3. Why should we give allowance for joint deformation? Explain in detail? (May / June – 2009) (Nov / Dec – 2013)

Various structural elements are made in the plant or prefabricated when these elements in their site there may be joint deformation to take it workout deformation. An allowance is tolerance or dimensions of the pre fab units are given in the design.

This is the limiting value of the permissible or admissible deviation in the size or shape of the finished prefabricates from the design requirements.

In practice it is not possible to make products which will have the exact design dimension. Extreme precision is not possible as in accuracies or unavoidable during erection.

The designer should be able to forecast or even to tell the maximum tolerance value or the allowance which will make the correct assembly and efficient functioning of the individual prefabricates. The decreasing tolerance leads to the increased cost of protection and optimum value of permissible deviations must be established large admissible deviations which are normally made positive as a safety factors lead to waste of material in mass production.

In making large block prefabricates the average volume of concrete in their products was increased by 1.5%(the thickness of the blocks was on the average 0.5cm) with the production of 3000m3 of concrete per month the excessive month use of cement is nearly 15 metric tonnes.

Deviations in the dimensions of products are important to the production equipment main the frame work. The materials used in formwork and the manner in which the parts of the forms are joint together are the important face because of the deformability and their tendency to warp with moisture, the timber forms can no ensure the accuracy like steel or concrete forms. Bolted connections are not recommended for formwork because of difficult of thread cleaning. The best accuracies obtained with self locking or wedged forms.

As in the machine tool industry, degree of precision is important in prefabricate building industry. There is a conventional scale defining the maximum permissible allowance or tolerance. The small is in relation to the theoretical dimension of prefabricates.

The following table gives the values degree of precision and basic tolerances or allowances (dimensions and tolerances in mm).

Degree of precision required	Dimension of 10 m			Dimension of 60m	
	Upto 100	Upto 100 to 300	300 to 3000	3000 to 9000	Above 9000
3	0.5	1	2	3	4
4	1	2	3	4	6
5	2	3	4	6	10
6	3	4	6	10	16
7	4	6	10	10	25
8	6	10	16	25	40

In design it is advisable to design of frame work with an assumed 3rd or 4th degree of precision not less than the 5th degree.

For non-structural components 6th degree precision is sufficient if the dimensional co0-ordination is not affected.

The following rules are followed to decide the overall nominal degree of precision of a prefabricate.

From only one dimension is critical, the degree of precision corresponding to the dimension of the component.

When more than one dimension of the component are allowed tolerance or allowance of precision corresponding to the most critical or vital dimensions are calculated.

The degree of precision must be shown in the working drawings which make to know about the type of formwork for the given type of formwork the following specific ranges of precision are assigned.

- Steel or cast iron moulds= 4 to 5
- Concrete moulds= 4 to 6

- Vertical battery moulds, steel= 5 to 8
- Vertical battery moulds, concrete=6 to 8
- Collapsible steel forms=5 to 8
- Timber forms bolted or welded=7 to 8

In order to follow the design tolerances, the fabricates of formwork must be accurate by at least one degree. The admissible dimensional deviation of prefabricates are

(a) Blocks:

Thickness = -0+5mm

Width = -5+8mm

Length = -15+10mm

(b) Panels:

Thickness = -0+5mm

Width =-5+10mm

Length =

(c) Beam and Column:

Thickness = -3+5mm

Width= -5+5mm

Length = -15+15mm

For the forms, the maximum allowance or tolerances are the following range.

(i) With timber forms:

Thickness= 7.5 to 14mm

Width= 6.5 to 24mm

Length = 10 to 30mm

(ii) Steel forms:

Thickness= 3 to 20m

Width= 11 to 22mm

Length = 8 to 28mm

The limiting values of allowance are calculated for the following formula.

$$\partial 1 = +b\left\{\frac{l+0.6b}{l+b}\right\}$$

$$\partial 2 = -2\left\{\frac{l+0.6b}{l+b}\right\}$$

$$\partial 3 = \pm\left\{\frac{5l}{l+b}\right\}$$

$$\partial 4 = \pm 5\left\{\frac{l+0.6}{l+b}\right\}$$

Where,

l → length of the edge for which the tolerance is calculated in 'mm'.

4. Explain briefly about principles of design:

In a prefabricated building the structure must be sufficiently rigid in all directions and the load bearing system must be simple and clear-cut solution in which the fixity condition of units are doubtful, where the load bearing functions of individual elements are difficult to define or where the points of application of loads are uncertain, should be avoided.

In particular precast and insitu work forming parts of the load bearing walls of a single storey should not be mixed. If for any functional or practical reasons some walls or column must be constructed insitu due consideration must be given the design to the differential archaeological deformations which will take place in the wet and dry work.

Examples of poorly defined support conditions.

i. Wall element partly resting on odd and partly on new concrete.
ii. Load bearing walls of two different material

In the improved design the part of the wall composed solely of precast panels is distinctly separated from the other half, in which insitu cast and wall occur. Slender beams joining the two halves of the wall make allowance for a small difference in the vertical deformations.

The spaces between these floor level beams are filled with panels built of small gas concrete blocks should the relative movement of the two of the wall be of any applicable magnitude cracks will form in the infill panels they will not affect the load bearing capacity of the structure. In the original design cracks in the insitu girder wall would lower the strength of the whole wall.

Because of the shrinkage of fresh concrete with the consequent formation of crakes, is also invisible to introduce insitu stiffening wall into an otherwise prefabricated building. It is perfectly in order; however, to construct insitu the stiffening "core" of the building to which in the second stage of erection, the remainder of the building made of prefabricated units is connected.

There are no structural objections to part precast and part insitu floor construction. The differential shrinkage movement in fresh and nature concrete need only be considered in design calculations concerning large span beams, prefabricated parts of which are joined together with insitu concrete. This type of construction however is sold used in having projects.

Equally acceptable are monolithic floors on prefabricated panel walls or precast floor supported on insitu walls, provided all walls of a given storey are insitu.

The spatial rigidity of a building made of prefabricated units is achieved by means of rigid longitudinal and transverse walls, which extend the full height of building.

These walls distribute over the foundation two kinds of horizontal load, namely, force due to direct wind pressure on the external walls and horizontal force resulting from the non-vertical or non-symmetrical layout of the load bearing walls.

Because of the presence of the stiffening walls only vertical load needs be considered in the designed the load bearing elements in a building.

From the structural point of view, it is possible to provide the necessary lateral stiffness by means of beams and columns rigidly connected at the joints. The results, however in increased consumption reinforcement and additional production difficulties, and is therefore admissible only when economically justified.

Foundations:

The foundation of a building may be insitu or may consist of large prefabricates. In either case, the underground structure must be very rigid and must ensure an even distribution of loads over the plan area of the building. Building assembled from prefabricates are very prone to the formation of cracks in construction joints. The designer must make certain that the whole building will settle evenly acting as a three-dimension rigid body.

As a role, insitu construction below ground level adequately ensures an even distribution of load over the plan area.

In soils of low compressibility large prefabricates can provide a satisfactory foundation structure. Attention must be paid however to the rigidity of connections one way of ensuring this is to block bond the units, as in masonry walls.

fragment of the prefabricated underground structure of a building.

i. Cellar floor level.
ii. Insitu ring beam.
iii. Insitu concrete infilling.

Architectural concept:

When the architectural concept walls for a building with very wide windows external walls should be designed as non-structural walls [e.g.] certain walling.

Although sometimes practised in long wall and ring wall buildings it is not strictly correct to design external wall as load bearing or even self-supporting if panels with large window openings are required.

All chimney flues and ventilation ducts should be grouped in walls running parallel to the span of the floor panels.

The walls housing these ducts should be self-supporting when it is possible to cap them efficiently to the structural walls of the building the chimney walls may be assumed to have a stiffening effect on the structure.

All lintel blocks below ground must be given generous bearing to ensure the monolithic behaviour of the foundation walls.

When considerable ground movement are anticipated the design of the underground structure should be insitu monolithic with suitable small expansion joints. The span of the foundation walls should not be more than three times and the thickness, not less than 1/20 of their height.

In skeleton construction the walls dividing the total space in to individual apartments should also be placed over the beams and not on floor panels.

Dividing walls should not be located in the middle floor panels because of the ensuring loss of useful space thickness of the wall and the increased consumption of steel. [Concentrated load at mid span].

Before precast foundation bocks are laid the soil must be carefully levelled and compact with the addition of hard core. If necessary blocks should be bedded in cement mortar eliminated dry spaces between them and the ground.

A monolithic reinforced concrete beam should be constructed immediately and the foundation block.

A similar ring beam should encircle the building at ground floor slab level.

Correlation of Structure and Architecture:

The structure of a building most reflects the architectural concept. In designing buildings with load bearing walls the normal profile is to utilise the latter to separate individual apartments load bearing walls as a rule make adequate acoustic barriers.

5. Write the detail about design of cross section based on efficiency of the materials. (April / May – 2011)

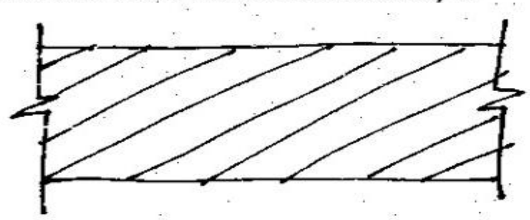
Prefabricates are classified as homogenous and composite based on the number of different material used in fabrication.

Homogenous prefabrication:-

The prefabricates which have only one material are called homogenous prefabrication. The homogenous limit may be hollow, solid, ribbed.

Solid:-

(i) If the units have plain & ordinary cross section which form a total mass of structure are called as solid C/S.



Hollow: -

(ii) The prefabricates which have hollow (or) opening (or) cores in it are called hollow prefabricates. This openings are used ventilation for taking any line which may be Electric line, water line.

Compound wall panels:-

These are panels made up of many panels called as composite panels. This is also called semi prefabricates which are joined together during the erection: Those panels are produced in industry. The production process is mechanized & easier than sandwich panel.

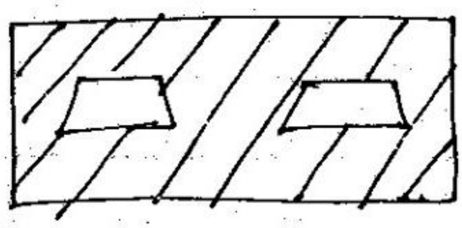
The compound wall panels may have two identical waffle section produced by vibro rolling. They are joined together by facing the ribs invert with mineral wool insulation b/w them.

Compound panel may have semi pre-fabricate which are glued (or) attached to the polystyrene insulated slab. Outer panels are joined by means of steel cramps.

The erections are done in two stages. The concrete panels are first fixed to the structure and the internal part (insulation & lining) is then erected from inside.

Ribbed:-

(iii) If the prefabricate have the ribs in it they are called ribbed section (or) ribbed panel section.



Composite prefabricates:

A prefabricate with more than one material us called a composite prefabricates.

Here many materials in different layers unit joint together to form single prefabrication (or) sandwich unit. Here reach and every individual layer of these pre-fabricate may take various forms of construction. The composite prefabricates are also classified into three types.

1. Solid section
2. Cored section
3. Ribbed section

Here the solid c/s section more than one material with two layers.

(i) Structural layer

(ii) Non-structural layer

Structural layer takes the load on the Structure and safely resist (or) withstand the loads. The Non-structural layers are insulation (or) finishing layer. This insulation protects the structure from thermal radiation (or) heat.

(b) Cored section:-

Those are the section which have different (or) cores in it and made up of more than one material.

(c) Ribbed section:-

They are prefabricates with ribs in it these ribs are the structural layers and withstand the load. Here also the non-structural layer (or) the outer finishing layer is used to protect the structure from the heat effect and do not carry any load.

Here also more than one material is composed in the pre - fabricate.

Another types of competitive prefabricate is skeletal pre-fabricate. This is the one in which one material forms a frame work filled with another material which us lighter (or) weaker.

Another type of composite pre-fabricate us one which have ribbed panels and insulating layers made up of some (or) different materials.

Here the ribbed panels take the load and form the structural layers of composite prefabricate. The insulation layer is protective layer.

Design of cross section based on efficiency of material used:

Based on the single or more than single material, the member are classify as above.

The cross sections of precast reinforced concrete structure are normally having the following steps.

i. Tee section
ii. I section
iii. U or V section

The shape may be solid and their profile can be hollow or divided (practiced latticed) and vierendeel structures.

Beams:

The beams have rectangular I, T, V shaped and hollow.

Rectangular Section:

This is the method simple cross section of precast structure these sections to be produced is small number the advantage simple pre-fabricated. The disadvantage rectangular sections are not economical.

The other section I, T, V shaped V and hollow cross section are frequently used in pre-fabrication. The advantages of these sections are

For the react c/s, F'=b.h ------------------- 1

$$\therefore k = \frac{b.h^2}{b} = k$$

$$\therefore h = \sqrt{\frac{6k}{b}} \text{ ------------------- } 2$$

Put 2 in 1,

$$F = b.\sqrt{(\frac{6k}{b})}$$

$$F = \sqrt{6kb}$$

Hence $\varphi = \frac{F}{F} = \frac{F}{\sqrt{6kb}}$

For a rectangular c/s, $\varphi = 1$

For other section T, I, U and V shape etc for this cross section $\varphi \leq 1$

The smaller the values of φ, the c/s is more economical.

For ex: in case of a homogeneous of beam I shaped c/s .

They are precast RF concrete beams of equal load bearing capacity.

$F=2260\ cm^2$

$b = 48\ cm$

$k = 48500\ cm^3$

The depth of equivalent rectangular c/s is, h=77cm

The form factor of the I-section is,

$$\varphi = \frac{F}{\sqrt{6kb}}$$

$$= \frac{2260}{\sqrt{6 \times 48500 \times 48}}$$

$$= 0.605$$

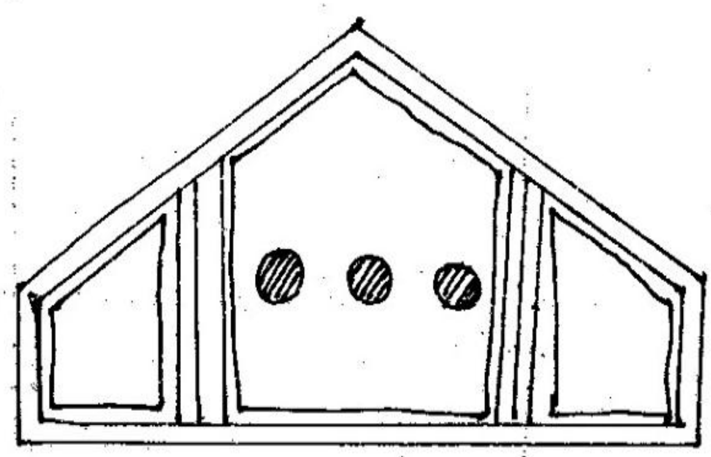
$$\therefore \varphi = 0.605$$

The value of $\varphi = 0.605$ means that in the case of beams made up of timber, steel are another homogeneous are same material have the same tensile strength. The application of I section is as shown in above fig. Instead of a red profile with the same width, makes to save in material of 39.5%.

This concept is called the design of c/s based on the efficiency of material used in prefabrication.

Fretted latticed and Vierendeel structure:

Generally, there is no difference in construction between the solid beam and a fretted section. The different openings are provided in the fretted beam only to obtain savings in materials and to reduce the dead load.



This girder or beam has openings to reduce the dead load and savings in material cost. The fretted works or fretted section, latticed truss, vierendeel structure are mainly used in prefabrication because the dead load is very much reduced a very high material savings is achieved.

These are called as the design of different c/s based on the efficiency of material used in prefabrication structure.