

Unit –IV JOINT IN STRUCTURAL MEMBERS

4.1 Expansion Joints

An expansion joint is an assembly designed to safely absorb the heat-induced expansion and contraction of various construction materials. To absorb vibration, or to allow movement due to ground settlement or earthquakes. They are commonly found between sections of sidewalks, bridges, railway tracks, piping systems, and other structures.

Expansion joint design:

A design specification shall be prepared for each expansion joint application. Prior to writing the expansion joint design specification it is imperative that the system designer completely review the structural system layout, and other items which may affect the performance of the expansion joint. Particular attention shall be given to the following items.

The system should be reviewed to determine the location and type of expansion joint which is most suitable for the application. Both the EJMA Standards and most reliable expansion joint manufacturers' catalogs provide numerous examples to assist the user in this effort. The availability of supporting structures for anchoring and guiding of the system, and the direction and magnitude of thermal movements to be absorbed must be considered when selecting the type and location of the expansion joint. Conventional rubber expansion joints are designed to provide stress relief in piping systems that are loaded by thermal movements and mechanical vibration. To deal with the various forces on the joint they require fibre reinforcement which guarantees both flexibility and strength. Conventional expansion joints are reinforced using prefabricated fibre plies. The use of these fabric plies makes it impossible to control the orientation of the fibres on complex shapes such as the bellow of an expansion joint. In both cases the inability to use the fibres in an optimal way leads to the following disadvantages:

High Material Cost:

- ☐ More fibres needed than necessary
- ☐ More rubber needed than necessary
- ☐ Additional parts such as metal reinforcement rings necessary with multiple bellows

Lower Performance

- ☐ High rubber wall thickness and fibre pack make product less flexible
- ☐ Undesired radial and axial expansion under pressure.

1) Introduction 2) Necessity 3) Advantages 4) Pre requisites 5) Types of prefabrications

Pre-fabrication means that the structure is disunited in its disunited in its members and

these are precast in factor built and equipped particularly this purpose or in temporary

plants establish on the site. Then the precast reinforced core members are shipped to the

place where they used. Here they are hoisted set into their fix places and assembled in the

form of a complete structure. The stages involved are

- 1) The structure is divided into no of units.
- 2) The different units are precast in permanent plants.

Permanent prefabrications - plant prefabrication.

Temporary plants (sheds) - Site prefabrication

- 3) Transported to the site

- 4) Hoisted and put into their places

Prefabrications eliminates the use of scaffle.

Necessity:

Million houses in rural areas.

20 million houses in urban areas speedier construction.

Conventional methods - time consuming

- The components are not a man power is not effectively.

Factors:

- 1) Cellular concrete plant at Madras
- 2) Hindustan Housing Factory at New
- 3) SIPOREX, India Limited at Poona
- 4) Key Jay Spirole private limited.

In New Delhi they are manufacturing -sleepers & poles.

Object or AIM:

- 1) To accelerate the building construction.
- 2) To increase the building activity.
- 3) To effectively utilize the man power.

Pre-Requisite:

- 1) Large demand of flats in a limited area
- 2) Availability of adequate funds & buildings materials
- 3) Prospective planning of building activities and long time orders.
- 4) Standardization allowing mass production
- 5) Adequate mechanization of production process.

4.2 Advantages of pre-fabrication over the monolithic methods of construction:-

1. Partial or total saving of material used for scaffolds.
2. Multiple use of structuring
3. Possibility of far more accurate and better work transits.
4. Cross sections more advantages from the new point of stream
5. Working time can be shortened.
6. Fewer expansion joints are required.
7. Interruptions in concreting can be omitted.
8. The work can be carried out with a high degree of mechanization.
9. Requirements in man power decrease.
10. Helps to avoid the seasonal character of the buildings industry.
11. Re use of the members. In pre fabrication scaffolding materials are needed as a temporary support.

The single set of moulds can be used from 10 to times in case of small members. Only the lateral boards are made of timber and the other parts being usually of R.C. In case of plant prefabrication the moulds are made of steel. If they are made of timber. They are covered with steel steels. The same structuring can be used for casting both small and large members.

Since the members are produced in easily accessible places on the ground better. Workmanship can be obtained the moulding assembly of the reinforcement and the concreting can be performed more precisely due to better workmanship and higher strength can be obtained. Since the permissible and limit stresses can be higher, cross sections can be decreased resulting in the decreases in dead load. The reduced dead load means less concrete and a decrease surface of structuring resulting in the reduction of prime and the use of cross sections which are structurally advantages namely an I profile or tresses does not cause particular difficulties in prefabrication. The application of such a cross section or a tress instead of a girder would be much more difficult in the case of monolithic structure. Even unreasonable because of the complicated shultering, reinforcement and concreting. In the monolithic construction the separate builds spaces can be performed only in sequence namely the foundation. There the concrete, reinforcements, then the concreting of the structure. In the ease of prefabrication these constructional process namely the generally started, beginning of the foundation work. The estimation that about 80% of the time is required for prefabrication and 20% for site works. The greater part of shrinkage of precast concrete members occurs before their placings because of numerous joints the effect of temperature changes is also far less important and hence the spacing of expansion joints can be increased. In monolithic structures it is the duty of the foreman to select palces where

concreting can be interrupted. A matter not usually fore seen by the designers who does not deal with the problem on the other hand for pre-fabricated structures junctions must be carried out according to plans of later place specified and considered by the engineer. In the fabrication since the work is carry out on mass scale we can go in for mechanization instead of manual labour and thereby the quality is considerably improved. In the case of prefabrication the application of industrial methods makes possible the employment of hands adequately trained within a few weeks. The work is carried out throughout the year it is always easier to give labourers for works to be done in a permanent

Plant prefabrication is absolutely independent the vagaries of the weather. In the case of site prefab the production of smaller members namely roofing members, wall panels, windows, purlins etc can be made in a covered place. In the case of large members the same is not possible but they can produced at an earlier date during favourable weather conditions. In the case of monolithic construction it is difficult to carryout the work during rainy seasons. The dismantling of building constructed of precast members and the use of certain of these at other places is possible in the case of pre-fabrication such a thing is highly impossible with monolithic structures.

Production techniques in pre-fabrication

In Concreting : 1. Moulding the concrete to the require shape.

2. Hardening of concrete.

In prefabrication : 1. Refined methods of moulding

2. Accelerate the rate of hardening objectives in the manufacture of

pre-fab compoenets are

1. Least amount of labour.

2. Specailist possible production.

3. Imporved quality

4.3 Types of Structue

1. Fame less - large paneled

structures - External and Internal

wall panels - Floor and roof panels (of room single)

2. Framed buildings : Columns, beams & floor elements.

Stages of work in pre-casting

Concrete Mould Steel

Mixing Preparation Cutting

Filling Reinforcing

On -SITE : Open yard casting or covered but purely temporary or semi-permanent type of set-up with partly mechanized facilities.

Factors Influencing method of manufacture

The single and the total no of elements to be produced

1. The single of the element may decide the reinforcement of space for production as well as the capacity of the handling equipment is decided by the theorist element.

2. Desired rate of output: This will have direct bearing on the no of moulds required degree of mechanization and need for accelerated method of curing.

3. Shape, type and construction features of these elements

Features such as special shapes, projected reinforcement, required finish on the surface on single layer or multi layer largely influence the design of the mould and technical castings.

Horizontal casting techniques are favoured for curved elements, multi layered elements and element which require some particular finish vertical casting is favoured for single layer solid panel which require no special finish on their surfaces.

4. Facilities available in the production set up : An accelerated curing facility will result in quick turn over of mould which can be advantageously used.

Machineries like over

head gantry crane, will aid speedy production in handling.

5. Economic aspects : The cost of production should be minimum.

Both moulding and demoulding in horizontal position -External panel wall ; floor panes with protruded reinforcements, beams, columns, etc.

-Extra reinforcements to take ease of bending stresses.

Tilting Moulds :

Demoulding is carried out in almost vertical position. No extra reinforcement is necessary.

One end is hinged and the other end is lifted with the aid of a jack or lifting equipment. Slip forming & Extrusion:

This method is achieved with a moving machine mould which forms the cross sectional shape of the element and the element hardening at the point where it is moulded. Precast pre stressed floor elements both solid & hollow are manufactured using this

techniques. Concrete laying - slips (Concrete buckets of various capacities)

Spreading - either manually or with a mechanical spreader.

Vibrating - with the help of shutter vibrates.

Screening - long & heavy wooden floats surface finishing - Travelling.

4.4 Mould for a pair of wall panels:

Vertical Moulding:-

Best suited for panels that require a smooth surface on both sides.

Advantages :

1. A large no of units can be produced in a small space.
2. Concreting the units proceeds fast.
3. No need to spread the concrete
4. Surface finishing not necessary due to smooth mould faces.
5. Heat of hydration developed is conserved and accelerates curing.

Single Moulds:

These are employed for casting volumetric elements such as sanitary units, ventilates shafts and refuse chuter. Battery moulds are employee for internal panel walls and floor panels. The swing down moulds are used for simultaneous manufacture of two wall panels.

Flow Line Production :

This is a travelling horizontal mould system in which the moulds are moved and the element from one position to the rest a series of stations, such as demoulding, mould cleaning and oiling, placing of reinforcements concreting vibration, surface finishing and curiving a stream chamber forms the part of the continuous travelling a chain and the chain can be in the horizontal plane or in the vertical plane.

Schematic diagram of flow line production:-

Moulds:-

1. They should have volumetric stability to ensure dimensional accuracy.
2. They can be reused a large no of times with minimum maintenance cost.
3. They should be easy to handle and close tightly so that no liquid can lead out.
4. They should not have adhesion to concrete and easy to clean.
5. They can be sued for various cross sections shapes of the components.

Wooden moulds:

1. Concrete sticks more easily. to prevent this, a coating of mould oil or wood lequer is given.
2. It can be used 30 to 40 times. The dimensions should be checked frequently.
3. They are used fro smaller production programmes.

Steel Moulds :

1. Because of the smooth surface demoulding is fairless easy.
2. Indiscreminate harmmering by workmen should be avoided.

Concrete moulds:

1. These are used in vertical battery moulding.
2. The workability is low
3. These moulds enable high degree of dimensional accuracy, but are unsuitable for

making modifications.

4. These moulds are stationary not often transported.
5. The surface of the mould must be absolutely smooth or otherwise excessive adhesion may cause difficulties in demoulding.

Plastic Moulds:

1. Moulds made of glass fibre reinforced plastics are commonly used.
2. They have the advantage of freedom of shaping and low weight.
3. Demoulding is
4. They are easily transportable.
5. The same mould can be used 70 to 80 times without repair.

Manufacture Of Precast Elements:

1. Wall panels :-

Type of moulding depends upon the constructional features and the surface finish. In the case of internal panel wall-vertical battery wall. In the case of external panel wall horizontal moulding is usually done.

2. Roof or Floor Elements:

Depends on the type of building we construct whether residential or public building with large span. In the case of residential building the entire roof or floor is cast as a single unit. In the case of public building where long spans are encountered. The elements are cast in the form of hollow core floor slabs. Trough units and ribbed slabs which are normally of PSC.

3. Beams and Column :

Usually horizontal moulding is done. In the case of staircases vertical or horizontal moulding is done. In the case of sanitary units vertical moulding (as a single unit) is done.

1. Placing of concrete by strips slips
2. Spreading of concrete is done manually or mechanically.
3. Compaction by vibrators or by vacuum process or pressing.

In the case of vibration it is effected by means of internal vibrations and external vibrations. Internal vibrations in the form of immersion vibrators is used in places where we have congested reinforcements. External vibrators are generally used with steel moulds. Vacuum process is suitable for components with large surface area or relatively thin

elements. In the case of compaction by pressing. The freshly poured concrete is subjected to a pressure of about 70 ksc. It sequences out excessive water forming a cohesive slab which can be immediately remoulded.

Accelerated curing techniques are adopted for quicker turnover. It may be in the form of steam curing or heat treatment. Hot water or hot air. The duration of steam curing cycle is influenced by the factors like type of cement, water cement ratio, size of the members, the desired strength. With proper steam curing it is possible to achieve 60% of the moist cured 28 days strength of the concrete in 24 hours. In open casting yard for steam using specially made hoods are used which are insulated and sealed to prevent excessive loss of heat and moisture. In the case of flow line product. The chamber is sufficiently long to ensure that the products remain within the chamber for the desired time.

Demoulding and storage:

The units are first demoulded from the sides and then from the bases and the earthwork required to separate the unit from the base is more than the weight of the unit to account the adhesion of the unit to the base. Wall element are stored vertically. Floor and roof elements are stacked horizontally with & wooden strips in between two elements. Surface Finishing Techniques:

a) Surface formed in the mould.

b) Mechanical treatment of surface.

a) Textured surfaces are obtained by lining the mould with suitably patterned rubber

linings, plastic steel or timber. Smooth surfaces are obtained by resin coated or plastic lined mould surfaces.

b) This can be applied by freshly cast concrete or by the hardened concrete. In the case of freshly cast concrete. It is done by hand travelling or by rolling with a smooth steel tube on the compact concrete or by tamping with the edge of long wooden floor. In the case of hardened concrete. It is done by point tooling or by grinding the surface when soft aggregate are used.

Production Tolerance:-

By production tolerance use mean the limiting value of admissible deviations in the

actual dimensions. The deviations may be caused.

1.

2. Loose fitting of joints.

3. Joints and mould sides under pressure of concrete.

The limiting values are

1. Length $\pm 10\text{mm}$

2. Width $\pm 3\text{mm}$

3. Thickness $\pm 3\text{mm}$

4. Flatness - $1/300$ of the length.

Planning of precast concrete works:-

Requirement of space and facilities.

Space for production :

It is based on height and no moulds horizontal moulds -larger areas - vertical battery moulds -least amount of floor space. Height of the casting shed is based on space required. To lift and move one precast component over another. The head room can be sufficiently decreased by having moulds in pits. Extra space must be provides for making the reinforcements stages cleaning and up the demoulded units. Space for storage yard: This depends on the daily output and the demand. The space must be sufficient to store minimum of 3 weeks production. The storage yard may be preferably aligned with the casting shed to facilitate movement of overhead cranes. Space for facilities: This depends on the type & single of ancillary facilities required namely storage of raw materials such as cement, coarse aggregate & fire aggregate, reinforcement steel. Conc batching plant, fitters and joiners shop, Boiler and compress house. Laborator & Office. Modular co-ordination, standardization and Tolerance Basic Dimensions : This is the dimension between the axis defined by the dimensional grid. The dimensional grid is the two dimensional co-ordinate system of reference line defining the layout of the building. Nominal or Theoretical

Dimensions :

It is the planned dimension of the prefabricate arrived from its basic dimension and its joints.

Actual Dimensions :

It is the dimension of the prefabricated when produced and its differs from the nominal dimension by the production discrepancies which are unavoidable.

The tolerance is the sum of acceptable positive and negative discrepancies of actual dimensions from the theoretical one. The limits of tolerance are based on the manufacturing and erection requirements.

Modular Co-ordination : If the inter dependent arrangements based on the Pre Fabrication and System

Building Definition

Pre-fabrication means that the structure is disunited in its members and these are precast either in factories built and equipped particularly for this purpose or in temporary plants established n the site. Then the precise reinforced concrete members are shifted to the place where they are to be used, here they are hoisted, set into their final places, and assembled to form a complete structure.

Stages involved in pre-fabrication

1. The structure divided into number of units.

2. The different units are precast in permanent factories (plant fabrication) or temporary plants (site prefabrication).
3. Transported to the site.
4. Hoisted set into their final places and assembled to 1. Partial or total saving of material used for scaffoldings.
2. Multiple use of shuttering
3. Possibility of far more accurate and better workmanship.
4. Working time can be shortened.
5. Fewer expansion joints are required.
6. Interruptions in connection can be omitted.
7. The work can be carried out with a high degree of mechanization.
8. Requirements in man power decrease.
9. Re use of the members.

4.5 Design of expansion joint:

1. Basic Dimensions

This is the dimension between the axes defined by the dimensional grid. The dimensional grid is the two dimensional co-ordinate system of reference line defining the layout of the buildings

2. Nominal or theoretical dimensions

It is the planned dimension of the prefabricate arrived from its basic dimension and its joints.

3. Actual dimensions

It is the dimension of the prefabricate when produced

If the interdependent arrangement of the basic dimensions of the building based on the primary unit accepted components so that they apply to any building that is laid out on the 10cm (4") modular basis without cutting or altering at the site.

5. Planning module (Mp)

It is a multiple of the basic module for specified applications. The planning module $M_p = 3 \text{ cm}$ is the common horizontal dimension or $M_p = 1\text{M}$ is used for the vertical dimension, when $M_p = 60 \text{ cm}$ for the length dimensions.

6. Modular grid

This is a particular case of the dimensional grid consisting of two dimensional coordinate system of reference lines (modular lines) at a distance equal to the basic module or the multi module (M_p). This multi module may be the same or different for each of the two dimensions of the reference system. The area between the modular lines is called the modular

1. Easier design

Elimination of unnecessary choices.

2. Easier manufacture

Limited number of variants.

3.Easier erection and completion Repeated use of specialised equipment.

4.6.Factors influencing standardization:-

1. The most rational type of member for each element is selected from the point of production from the assembly serviceability and economy.
2. The number of types of elements will be limited and they should be used in large quantities.
3. To the extent possible the largest size to be used which results in less no of joints.
4. The size and no of the prefabricates is limited by the weight in overall dimension that can be handled by the handling and erection equipment and by the limitation of transportation. Hence it is preferable to have all the and transporting complete assemblies or sub-assemblies to the construction site where the structure is to be located. The term is used to distinguish this process from the more conventional construction practices of transporting the basic materials to the construction site where all assembly is carried out. The term prefabrication also applies to the manufacturing of things other than structure at a fixed site. It is frequently unused when fabrication of a section of a machine or any movable structure is shifted from the main manufacturing site to another location, and the section is supplied assembled and ready to fit. It is not generally used to refer to electrical or electronic components of a machine, or mechanical parts such as pumps, gearboxes and compressors which are usually supplied as separate items, but to sections of the body of the machine which in the past were fabricated with the whole machine. Prefabricated parts of the body of the machine may be called 'sub-assemblies' to distinguish them from the other components.

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The process and theory of prefabrication

An example from house-building illustrates the process of prefabrication. The conventional method of building a house is to transport bricks, timber, cement, sand, steel and construction aggregate, etc, to the site, and to construct the house

on site from these materials. In prefabricated construction, only the foundations are constructed in this way, while sections of walls, floors and roof and prefabricated (assembled) in a factory (possibly with window and door frames included), transported to the site, lifted into place by a crane and bolted together. Prefabrication is used in the manufacture of ships, aircraft and all kinds of vehicles and machines where sections previously assembled at the final point of manufacture are assembled elsewhere instead, before being delivered for final assembly. The theory behind the method is that time and cost is saved if similar construction tasks can be grouped and assembly line techniques can be employed in prefabrication at a location where skilled labour is available, while congestion at the assembly site, which wastes time, can be reduced. The method finds application particularly where the structure is composed of repeating units or forms, or where multiple copies of the same basic structure are being constructed. Prefabrication avoids the need to transport so many skilled workers to

the construction site, and other restricting conditions such as a lack of power, lack of water, exposure to harsh weather or a hazardous environment are avoided. Against these advantages must be weighed the cost of transporting prefabricated sections and lifting them

into position as they will usually be larger, more fragile and more difficult to handle than the materials and components of which they are made.

“Loren” Iron House, at Old Gipps town in Victoria, Australia Prefabrication has been used since ancient times. For examples, it is claimed that the world’s oldest known engineered roadway, the Sweet Track constructed in England around 3800 BC, employed prefabricated timber sections brought to the site rather than assembled on-site. Sinhalese kings of ancient Sri Lanka have used prefabricated buildings technology to erect giant structures, which dates back as far as 2000 years, where some sections were prepared separately and then fitted together, specially in the Kingdom of Anuradhapura and Kingdom of Polonnaruwa. In 19th century Australia a large number of prefabricated houses were imported from the United Kingdom. The method was widely used in the construction of prefabricated housing in the 20th century, such as in the United Kingdom to replace houses bombed during World War II. Assembling sections in factories saved time on-site and reduced cost. However the quality was low, and when such prefabricated housing was left in use for longer than its designed life, it acquired a certain stigma.