Prestressed Concrete

Notes by-

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Erection Technique:—

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Precast members must be hoisted and placed, according to plans with different hoisting machines. These hoisting machines can be divided into the following groups.

(a) Tower Cranes.
(b) Crawler cranes.
(c) Truck cranes.
(d) Gantry cranes.
(e) Mast cranes.
(f) Twinned mast cranes.
(g) Derricks.

Tower Cranes:— The tower crane is one of the most useful machines in the building industry. It is used in the first place, for the conveyance of building materials in a vertical direction and for the hoisting of precast members, but it is also suitable for any other hoisting or placing operation, as well as for horizontal transportation.

Crawler Cranes: Crawler cranes are particularly suitable for the hoisting and placing of precast members, because they are mobile and don't require a rail track; furthermore, these cranes are, in addition to hoisting, also able to transport the members. ~~One~~ In spite of this, these cranes have certain disadvantages. one of these is the detrimental and frequently damaging effect of these heavy machines travelling over previously finished concrete pavings. The second disadvantage is their lack of stability so that they may capsize if not skilfully operated.

Truck cranes: These cranes consist of the chassis, including the ~~motor~~ the motor and generator, and of the pivoting upper part. These cranes are mobile and travel on their own wheels, where they are suitable for hoisting & placing precast members

Gantry Cranes: These cranes are used mainly to serve the operation of the manufacturing and storing areas in prefabrication plants. In certain cases they can also be used for hoisting members. They are mobile and indispensable in pre-fabrication plants.

Mast Cranes: These cranes are widespread hoisting devices because of their simplicity and cheapness. Their operation, however, requires great skill and much practice. On the site they are often made of timber. The hoisting machine of a mast ~~of~~ cran crane can be hand operated or power driven.

Twinned Mast cranes: For hoisting large members to great height a special hoisting machine has been developed. These machines named twinned-mast cranes proved to be very good and are generally used in pairs.

Derricks: These are, in general, highly efficient hoisting machines. They are either stable or moving. The drawback of stable derricks is the limited radius of action, as well as the necessity for and high cost of repeated transfers. Therefore, these derricks are used rather for assembly to be carried out at the same place.

Erection at Site :—→

A production of members is carried out in some specially prepared, generally, in covered premises in works or on site. The erection process is of necessity one which is undertaken in extremes of temperature and weather conditions. For erection to be completed satisfactorily the process of manufacture must be carried through accurately and efficiently.

A number of the manufacturing activities in fact form the basis for further activities in erection and many items such as provision of bearing sockets bearing corbels, ties and the basic components of the structural connection

can, if carried out inaccurately or unsatisfactorily, seriously impede the site activity beyond all proportion.

The designer and detailer must have given due consideration to the design of the components in the light of the requirements of lifting, handling, and erection. Every attention must be given in manufacture to achieve a degree of accuracy which ensures that the components fit, and that a footprint is achieved at the earliest possible moment — minimizing the time during which the unit must be connected to the crane. For this reduced holding time the manufacturer must have jigged connections, and must have accurately positioned the sockets and bracing bolts to ensure that the site erector can fit the components and brace them quickly.

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Simple matters such as attention to the cleanliness of threads, the correct degree of projection of bars and loops and clearance of holes and sockets can make a major contribution to speed of erection. Apart from their tasks of specification, drawing and instruction, it is advisable that production supervisors and draftsmen should be given that opportunity of visiting site and seeing a complete cycle of the erection process take place.

Often, lifting arrangements and connections cause delay due to some small inaccuracy in the setting up at the casting stage and once the line supervisor has been the problem 'in the round' he will ensure that his personnel take care over those items in production.

A site visit will also serve to underline the difference in working conditions experienced by erectors compared with those of production, and the intelligent supervisor will quickly realize how a little extra care exercised in the relative comfort of the works may save hours of

discomfort for erection personnel. Such a visit can serve many purposes and will undoubtedly boost the morale of the production department who see 'his' units being rapidly incorporated into a structure which is of obvious value to the community.

The actual processes of placing, lining and levelling and connection are achieved by such a variety of means that only a general comment can be made here. The principles, however, are common to all systems and techniques, and the concept of programmed placing of accurate components into a soundly designed and rapidly erected structure apply throughout all precasting and erection processes.

The first requirement is that of accurately placed foundations or starters. Connections to foundations are made by inserting the precast components into pockets, onto dowels or onto holding down bolts. Apart from the actual connection, there are a number of other features which need to be checked, such as access roads, hard standing for cranage, office facilities, storage areas and compounds and of course, services to all these facilities. The position of projecting reinforcement from adjacent structural components must be checked as must be sockets, loops or dowels used to provide a fixing for the bracing, prop struts or whatever arrangement is to be made for the temporary support.

The second requirement is that of providing components of suitable commercial degree of accuracy, complete as regards fittings, connections and accessories necessary for lifting them into the allocated space in the structure. The components must be delivered on time and arrive loaded in the order such as to allow rapid placing into the building with minimum amount of double handling.

Provided that sufficient effort has been applied to the preparation of a mock-up assembly of pre-production samples then the units should seat onto the foundation bolts or arrangement of starters and bracing arrangement can be used to support them quickly and easily, thus freeing the crane for the next operation.

Of the correct degree of accuracy has been achieved then the components can be fitted quickly together, brackets, ~~etc~~ ties, loops or dowels should allow such operations as bolting welding or tying as are required to achieve the first steps of stability.

It is essential that all activities which effect the performance of the finished structure should be carried out under the supervision of suitably experienced and trained foremen and supervisors.

Waterproofing must be carried out meticulously sealants and prepared gaskets being inserted and attached to primed and suitably prepared surfaces. Care should be taken to ensure the completion of each joint to the specification and such that such joints should then remain undisturbed.

Erection Sequence: It is essential that the sequence of erection should be discussed with all the practical people involved and that the resulting programme allow all the activities of placing, bracing, lining, levelling and jointing to proceed in phase with one another.

A clear statement of sequence should be drawn and published to ensure that the components, which are critical to stability, are erected at the correct step in the operations whether they consist of precast or cast or laid in situ units. In the past

number of accidents have occurred because wind and sway bracing have been omitted.

An important consideration in any erection scheme is the provision of safety rails and barriers at slab edges and around openings, and the system should provide cast in fitting to accept the standards and post for fixing these items.

→ The stability of any part of the structure is ensured when all prefabricated components in that part are either stable of themselves or are connected into some system which is stable.

Components are stable when they meet the following conditions

$$G(x - e_i) \geq 0.6\, w\, b\, t^2 \quad \text{---------- (i) sq}$$

Diagram showing the self equilibrium of a prefabricated

where

G = weight of component

and $x \leq b/2$ is the smallest distance between the centre of gravity and the edge of the component,

e_i = ~~accidental~~ eccentricity resulting from unavoidable errors in the production and erection of the components given by,

$$e_i = \left[0.03 + \frac{l}{300}\right] h$$

$$= 0.02h + \frac{l}{300}$$

where l = height of the unit

w = wind pressure / unit area

b = width of the unit.

If above equation (1) is not satisfied, temporary bracing must be provided and maintained until the components are connected in three dimensions

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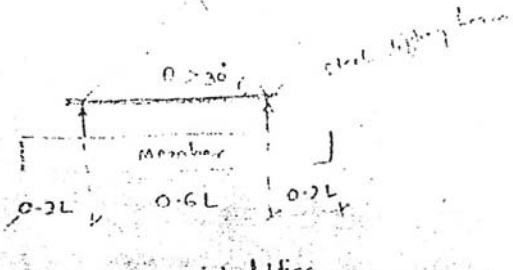
Columns Design for Transportation / Erection Stresses :-

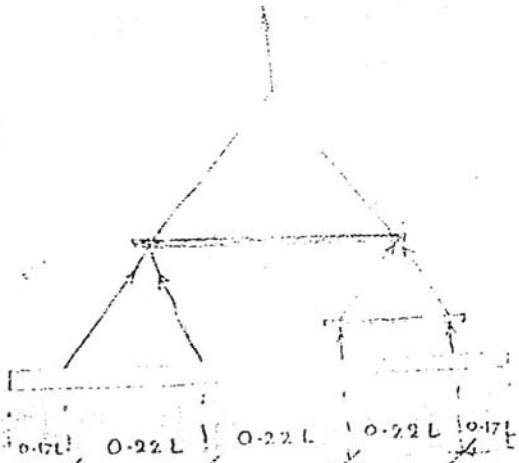
Columns are demoulded after a minimum of 15-18 hrs to facilitate a 24 hrs casting cycle. The concrete is fast cured as under steam or similar favourable methods such that the compressive cube strengths of the concrete is at least 20 N/mm². After removing mould/profiles the column is lifted at 2 points or 4 points in long columns at predetermined positions to minimise deflection and tensile strain.

Lifting points are usually at 1/4 to 1/6 of span from either end of the column because the optimum situation for equal sagging and bending moments is where the lifting point is at 0.208L from the ends of a unit length L. for very long columns a slender section l/D > 50 to 55, may require 4 point lifting because of unacceptable deflection in a 2 point lift.

Bending ~~stresses~~ are Moments and shear forces are calculated on self weight plus a 25% mould suction and impact allowance.



Two point lifting



when member is $\frac{L}{D} > 50$

Four point lifting