1984 1100 65

620 CONSTRUCTION TECHNIQUE

CONSTRUCTION TECHNIQUES FOR BUILDINGS

Lathika Jaisingh
Scientist, Central Building Research Institute, Roorkee.

Although housing is one of the basic needs of mankind and our population is far below the level of any acceptable standard of satisfaction in this section, we are not able to pay adequate attention in this direction. Reasons for this state of affairs are not far to seek. Some of them are:

- Housing has not crossed the threshold when it could become economically profitable proposition for the private entreprenuers. Consequently, it still remains a social welfare activity which the Governments and the Industry have to provide, for moral and ethical reasons rather than for financial motives.
- Land—the basic resource on which housing has to be provided—still remains a private commodity protected by age-old archaic regulations.
- Mounting population pressures and the increasing consumerism fuelled by highly developed mass media network (fast slipping into the hands of the private capitalists) is leading to a situation when priorities of the majority of the population get changed and the basic needs come under a shadow.
- Our socio-cultural chequered history which has given birth to a psychological climate where cooperative activity is neither spontaneous nor long-lasting. This situation leads to that Housing Cooperative movements do not generally succeed.

Keeping the abovesaid in view, one of the few alternatives left is to put more and more resources in the techno-economic aspects of the construction technology. It is to be done with the hope that some day, cumulative advances in technology would make itself attractive for the Government or private capital to find it financially attractive, consumer mentality would get lured by it, our socio-cultural ethos would get oriented towards the cooperative and community aspects (in the modern sense i.e. its institutional aspect) and finally ugly institution of private ownership and inheritance of non-agricultural land would give way to social ownership.

The techno-economic aspects of construction technology simultaneously fall into three distinct realms; i.e. the appropriateness of various concerned techniques with respect to their technical efficiency in our context; speed of construction because the backlog of housing is tremendous and so are the current requirements; and finally the economic aspect which includes reduction in use of costly building materials, skilled labour, saving techniques; efficient architectural designs of houses and layouts of groups; and again speed of construction (in the context of high bank interest rates on money).

Amongst various technical alternatives, small-scale prefabrication is considered, by many, as the most appropriate set of techniques for solving our housing problems in urban settlements. It is also claimed that, to a certain degree, partial and small-scale prefabrication would also help in the context of our rural settlements.

Floors and roofs account for about 25 percent of the building cost and consume substantial amount of scarce materials like cement and steel. Any saving in this item will go a long way in reducing the overall cost of the building. Considerable efforts have been put in by the Central Building Research Institute, Roorkee to develop ways of putting faster and economical roofing/flooring and some of these are briefly described in this paper. The techniques enumerated in this paper are neither new nor unknown. But there has been a lack of systematic utilization. Hence they call for a change of mental attitude and fresh thinking on the part of the builders.

Precast Concrete Channel Unit Scheme

In a slab, under load, compressive and tensile stresses are induced in the upper and lower portions of the slab respectively. Concrete being weaker in tension is reinforced with steel bars in the lower portion. In the lower portion the concrete is inactive. This concrete which is inactive is removed in the channel unit scheme. The precast concrete channel unit is trough shaped in section. It is 295 mm wide and the thickness is 130 mm *(Fig. 1)*. The units can be used for spans upto 4.2 m, having normal residential loadings. The reinforcement to be provided in the units and at supports are to be worked out. Depending upon the end conditions it shall be designed as simply supported or continuous. The units are to be designed for two stages of loading. For the first stage the units shall be checked for handling stresses. The units shall be able to withstand self weight, weight of concrete in the joints and incidental live loads at the time of laying the units, as simply supported units. In stage two, the units shall be checked for full loads under appropriate end conditions. The units are precast in moulds consisting of outer frame and an inner frame. The unit is cast in the space between the two frames of the mould. The vertical sides of the units have longitudinal corrugations for almost their full length and vertical haunches in the end portion. These units are structurally complete and do not require any propping during construction. The units are placed side by side across the span to be covered, on levelled surfaces of walls or beam supports as the case may be. The units are then aligned properly. The negative reinforcement in case of continuous floor/roof slab is placed in position at support. Thin cement wash is applied to the sides of the units and the joints are then filled with M-150 concrete. The corrugation on the sides of the units when filled with concrete, develop monolithicity and help in transferring the load transversely. Over this slab any conventional floor finish or weathering treatment can be given. For roof, a coat of bitumen is first applied on the entire surface and then the lime concrete or mudphuska with tiles over is laid.

Precast Concrete Cored Unit Scheme

The cored unit is a precast component having two circular cores throughout its length. The width of the unit is 295 mm and the depth 130 mm *(Fig. 2)*. The units can be used for spans upto 4.2m having normal residential loadings. The method of design and the procedure of construction of the floor/roof is in the same way as explained for channel unit system. While channel units provide a ribbed ceiling, the cored units provide a flush ceiling.

Thin R.C. Ribbed Slab Scheme

The thin R.C. ribbed slab scheme consists of reinforced precast ribs 110 × 200 mm spaced at 1 to 1.5 m centre to centre with 50 mm thick cast-insitu flange above *(Fig. 3-a)*. It can be used for floors and flat as well as sloping roofs in single and multistoreyed residential and other type of lightly loaded buildings. In case of heavily loaded buildings the size and the reinforcement of the ribs and flanges will have to be increased. Conventional floor/roof finish can be used above this slab. Ceiling plasater could be avoided in low cost constructions. The ribs are designed to act as rectangular beams during construction to support the weight of the concrete in the flange, shuttering and live load of workmen and equipments. They are designed to act as Tee-beams for full design loads after the concrete in the flange has attained strength. The flange is designed as a continuous slab spanning over the ribs. To keep deflections within permissible limit, the span/depth ratio for the flange and the rib have been kept as per the relevant provision of IS:456-1978. To ensure monolithic action of precast ribs with cast in-situ flange stirrups in the ribs have been kept projected into the cast in-situ concrete of the flange. The flange is cast with the help of shuttering panels supported on the precast ribs. The width of the shuttering panel for the flange is kept as clear distance between the ribs with a clearance of 5 mm on both sides. The lengths of the panels are kept in modules of 300 mm so that a combination of any sizes can be used to suit the span of the room. The shuttering panels are made of timber framing and plywood panelling covered with GI sheets. At least 20 re-uses could be expected from this shuttering. Alternatively, steel shuttering panels could be used in which case, the number of re-uses will be more. The shuttering panels are kept supported on 20 mm square M.S. bars projected out of the holes left in the precast ribs *(Fig. 3b)*. As the ribs are designed to act as rectangular beams for the loads during construction, no props are required in this type of construction. The panels are kept with their top surface in level with the top surface of precast ribs with the help of wedges. Gaps if any between shuttering panels or between ribs and panels are to be filled with mud mortar or lean cement mortar and levelled flush with the top surface of the shuttering. Reinforcement in the flange is assembled over shuttering as shown in Fig. 3a. The specified cover (15 mm) to the main reinforcement is ensured by tying the reinforcement to the projecting stirrups of the precast ribs at supports and by keeping cement mortar cover blocks below the main reinforcement bars at mid span. Concrete of M-150 with 12mm and down graded coarse aggregate are then laid over the shuttering and the ribs are compacted to a thickness of 50 mm by a plate vibrator. In the thin R.C. ribbed slab, the flange portion being insitu with the reinforcement provided continuous in the two perpendicular directions, the slab ties the longitudinal and cross walls together and behaves similar to cast-in-situ R.C. slab to resist forces due to earthquakes and wind loads.

With the same roof treatment above, ribbed slab is only slightly inferior to 100 mm thick conventional slab for its termal performance. This slab has got practically the same impact noise rating as the conventional slab. The fire resistance of this slab was found 1 hour and 40 minutes, whereas the fire rating required for residential floor is 1 hour.

Precast Concrete Waffle Unit Scheme

This scheme is suitable for roofs/floors spanning in two directions having a span of 9 m or above in either direction. The waffle units are precast units of the shape of an inverted trough, square or rectangular in plan having lateral dimensions upto 1200 mm *(Fig. 4)*. Nominal reinforcement is provided in the flange in the form of steel fabric having 3 mm diameter wires at 150 mm centre to centre both ways. The grid slab is analysed as two-way slab. The mid-span sections are designed as Tee-sections with precast flange taking the compression and main reinforcement at the bottom of the insitu concrete taking the tension. The support sections are designed as doubly reinforced rectangular beams with a width equal to the sum of the thickness of the precast webs and the width of insitu concrete joint.

Partial shuttering is necessary for supporting the slab assembly during construction and till its attainment of strength. 100 mm wide and 40 mm thick wooden planks at a spacing equal to the size of the units are placed in one direction only, supported by adequate propping and shoring. The units are placed in grid pattern above the partial shuttering. The joints with necessary reinforcements are filled with cast-insitu concrete (Fig. 4b). The finished slab has a pleasant grid pattern in the soffit.

L-Span Scheme

For sloping roofs, the Institute has developed the L-Pan system in which the prefabricated L-shaped panels of 3130 mm length and 480 mm width and 120 mm depth on one side are used *(Fig. 5a, 5b)*. Sheeting and purlins normally used in the conventional sloping roof are monolithically composed into single component in this scheme. Its smaller leg functions as rib of L-beam and the wider leg as sheeting. These full span components are supported on gable walls sloped at 1:4 or 1:3. In transverse sloping direction the flanges of L-panels rest on the ribs of adjacent lower panels with overlaps *(Fig. 5c)*.

Prefab Brick Panel System

Bricks being the most versatile, easily available and most commonly used material, the prefab brick panel system has been developed by the Institute to make full utilisation of this material. The system is based on prefabrication applied to bricks. The scheme consists of prefab brick panels and partially precast R.C. joists. The prefab brick panel is made of first class bricks, reinforced with two M.S. bars of 6 mm diameter and joints filled with 1:3 cement sand mortar or M-150 concrete. Panels can be made in any size but generally the width is kept 530 mm to 560 mm and length 900 mm to 1150 mm depending upon the requirement *(Fig. 6a)*. The partially precast joist is square shaped in section, 130 mm wide and 100 to 125 mm deep with stirrups from the joists projecting out. The overall depth of the joist with the insitu concrete above the brick panel becomes 210 to 230 mm *(Fig. 6b)*. These R.C. joists are designed as composite Tee-beam with 35 mm thick flange.

The joists can be designed as continuous beams also. But a certain stage destribution of moment should be done to keep the joist singly reinforced for negative B.M. at supports.

For assembly of floor/roof the joists shall be placed in position on the supports. Each joist shall be propped at two places equally dividing the length of the joist. The brick panels are then placed over the joists and on wall side by side. A gap of 20 mm is left between each panel. The joints between the panels are then filled with M-150 concrete. Distribution bars of 6 mm diameter one each on each panel parallel to joist are then placed *(Fig. 6b)*. Over this M-150 concrete is laid upto a depth of 35 mm. The prop shall be removed only after the curing period is over and the insitu concrete laid in the roof slab has attained strength. Over this roof any conventional flooring/weathering course can be given.

Concluding Remarks

An attempt has been made in the paragraphs above to discuss the techno-economical aspects of roofing/flooring schemes developed at the C.B.R.I. Alongside these techniques, considerable development has been done in the foundations and super-structural elements. Furthermore, work has also been done in the architectural, fire safety, indoor-climate and building material aspects of buildings. It is quite obvious that only a holistic approach, which takes into account all above-said technical aspects in conjunction with social acceptability parameters, is the only one likely to yield results.

Bibliography

1. Central Building Research Institute, Roorkee: "Cored Unit for Floor/Roof"; Data Sheet No. 3.
2. Central Building Research Institute, Roorkee: "Channel Unit for Floor/Roof"; Data Sheet No. 5.
3. Central Building Researach Institute, Roorkee: "Waffle Unit for Floor/Roof"; Data Sheet No. 6.
4. Central Building Research Institute, Roorkee: "L-Pan Roofing"; Data Sheet No. 10.
5. Jaisingh, M.P., Suresh Chand and Lathika Jaisingh: "The Reinforced Ribbed Slab for Floors and Roofs"; *Indian Concrete Journal;* July,1980.
6. Verma N.: "Pre-fab. Brick Panels for Low Cost Rural Houses"; *Journal of Institute of Town Planners, India;* September 1974.

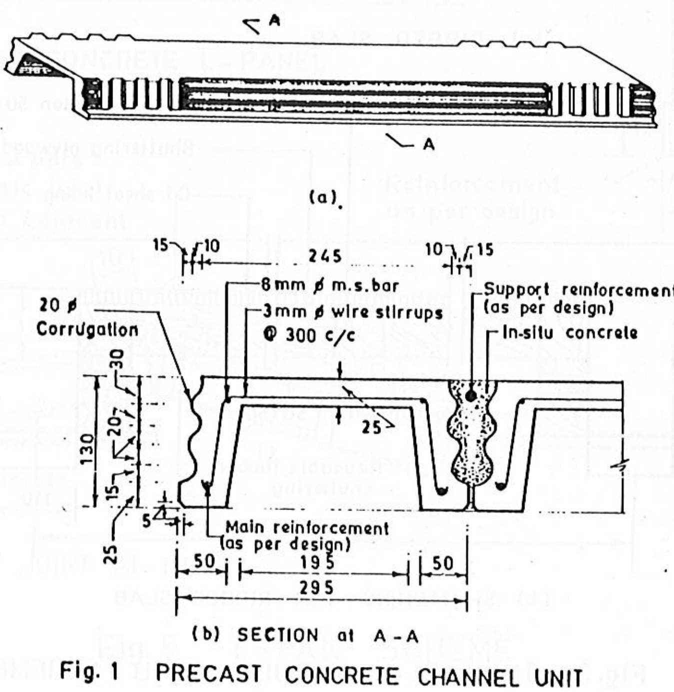


Fig. 1 PRECAST CONCRETE CHANNEL UNIT

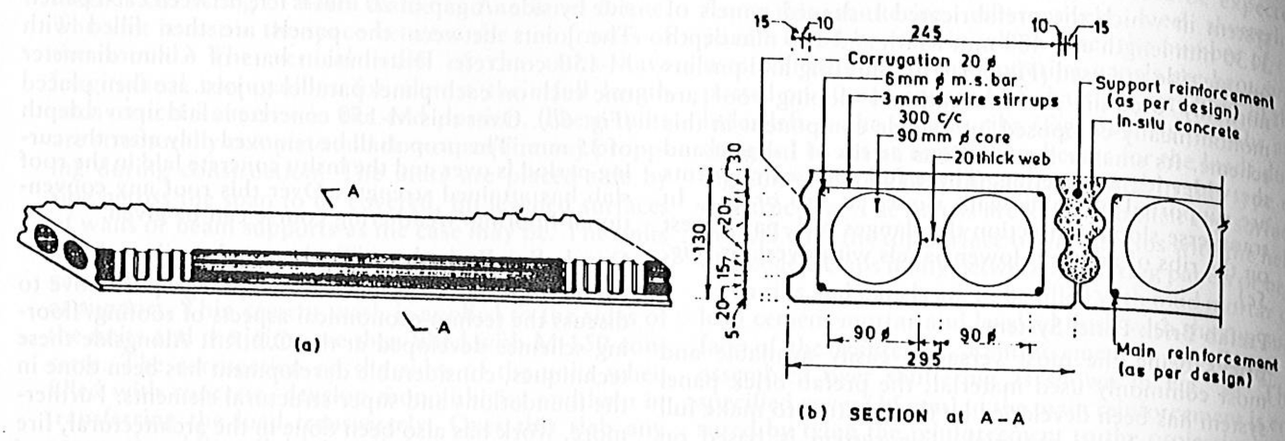
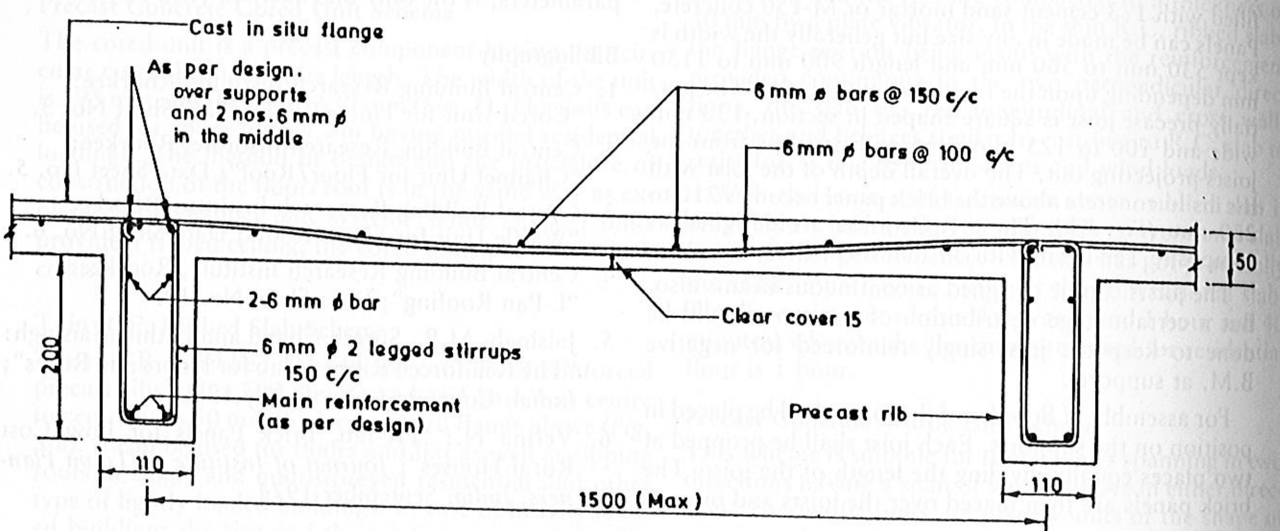
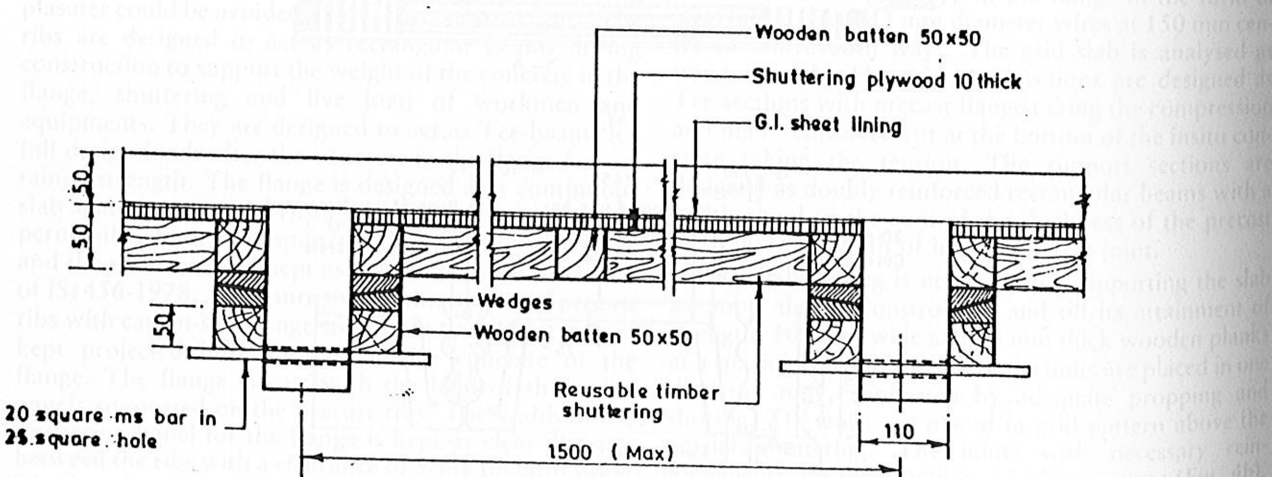


Fig. 2. PRECAST CONCRETE CORED UNIT

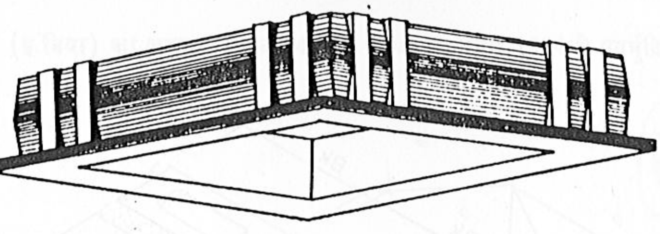


(a) RIBBED SLAB

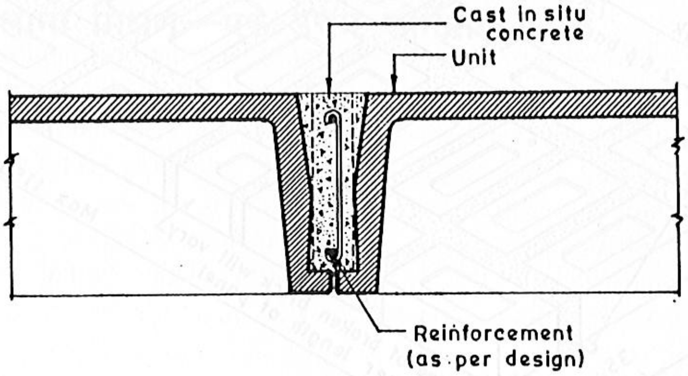


(b) SHUTTERING FOR RIBBED SLAB

Fig. 3 THIN R.C. RIBBED SLAB SCHEME

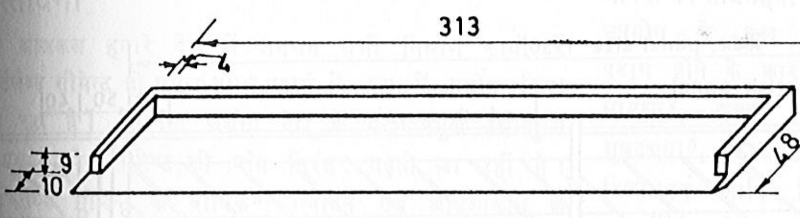


(a) WAFFLE UNIT.

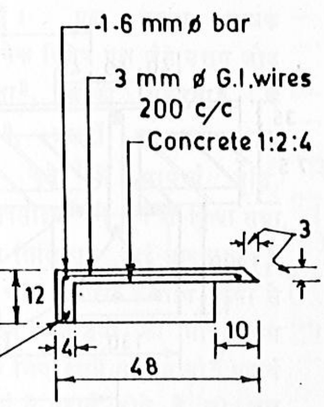


(b) ARRANGEMENT OF REINFORCEMENT

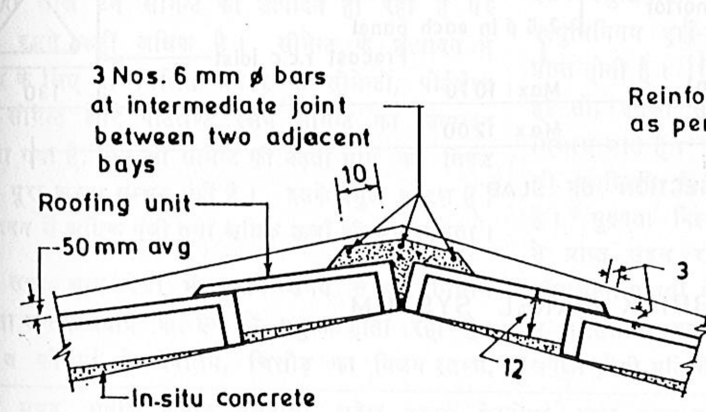
Fig.4 PRECAST CONCRETE WAFFLE UNIT SCHEME



(a) PRECAST CONCRETE L-PANEL

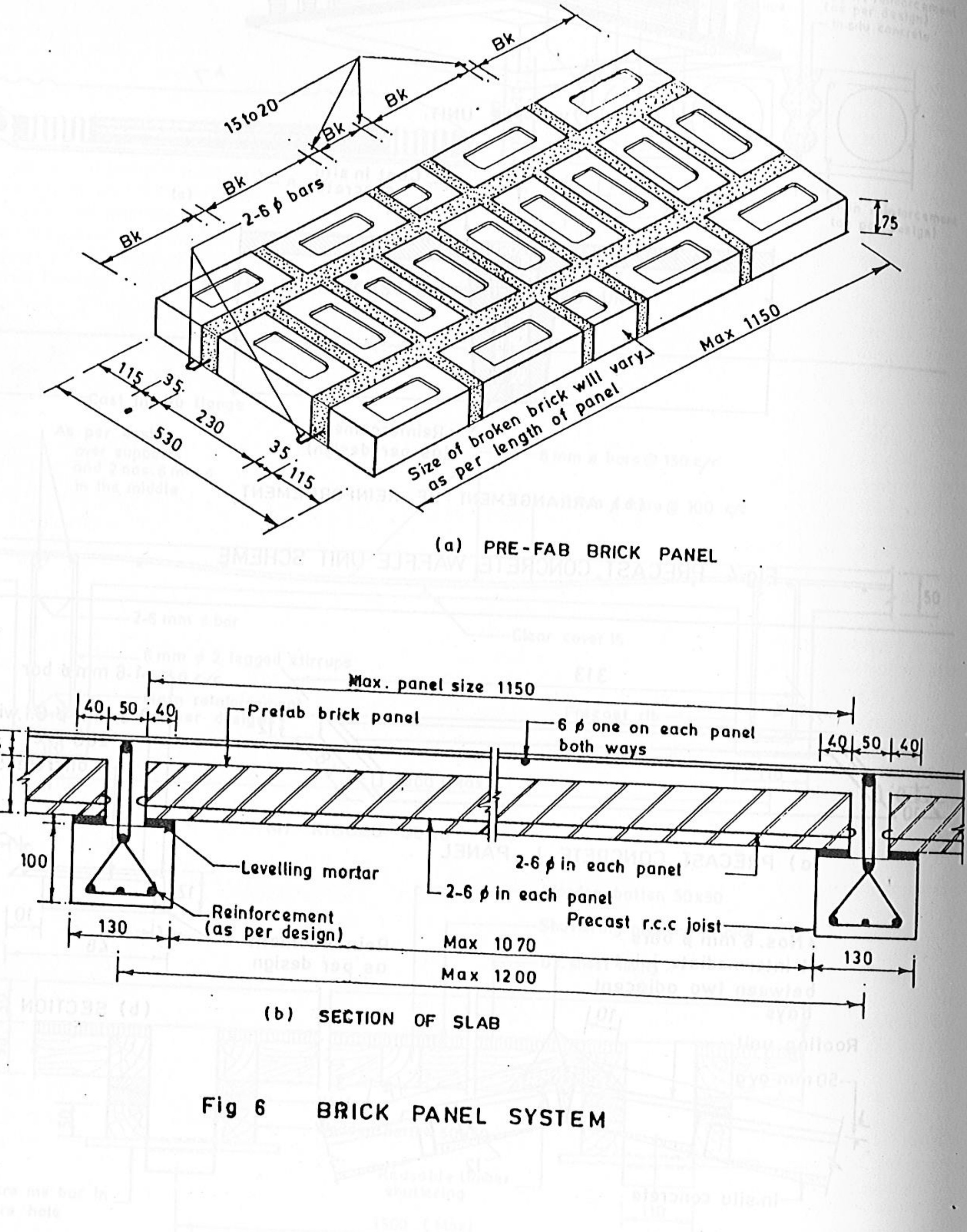


(b) SECTION



(c) JOINT AT RIDGE

Fig. 5 L-PAN SCHEME



(a) PRE-FAB BRICK PANEL

(b) SECTION OF SLAB

Fig 6 BRICK PANEL SYSTEM