CENTRAL BUILDING RESEARCH INSTITUTE, ROORKEE-247667 (INDIA)

BUILDING RESEARCH NOTE

B. R. N. 30

THIN PRECAST R.C.C LINTELS IN BRICKWALLS

In a wall with beam and masonry above, the two components act together in supporting the load. This phenomenon of composite action has been established by many research workers. Studies carried out at the Institute on thin precast R.C.C. lintels in brick-walls during 1964-65 has also shown that they act together, tension being taken by the lintel and compression by the brickwork. Based on these studies, 7.5 cm thick and 23 cm wide precast R.C. lintels with 3 Nos. 10 mm dia m.s. bars as main reinforcement were recommended for spanning openings upto 1.8 m, provided the bricks used have minimum compressive strength of 10 N/mm^2, the mortar is not leaner than 1:6 cement : sand mortar and height of masonry above the lintel is at least 45 cm. Based on these recommendations, such thin precast lintels are being adopted by many construction departments.

However, in most parts of the country, bricks of strength 10 N/mm^2 are not available. The Institute had been receiving queries from several agencies regarding the use of thin lintels in such situations. So, the feasibility of adopting thin lintels with low strength brickwork was studied and this Building Research Note is the outcome of the study.

Factors Affecting Composite Action

Composite action of lintel with masonry above is a complex phenomenon and the following are the major factors affecting it.

(a) Bond/friction at the interface of lintel and masonry :

The masonry above the lintel acts like an arch and transmits the load to the supports of the lintel and the lintel acts like a tie for the arch. For the lintel to act as a tie, it is necessary that the bond or friction between the masonry and lintel near supports, is more than the horizontal shear stress caused by the thrust of the arch.

(b) Crushing strength of masonry :

The arch action developed in the masonry causes vertical stress concentration in the masonry near supports. When this stress exceeds the crushing strength of masonry, failure sets in.

(c) Shear strength of masonry :

Once the shear stress developed in masonry near the support exceeds the shear resistance of masonry, failure sets in.

(d) Masonry bond :

For better composite action stretcher bonds are preferred to header bonds.

(h) Height of masonry above lintel :

If the height of masonry above the lintel is too little, physically it may not be possible for an arch to be formed in the masonry and hence composite action will be less.

(f) Whether the masonry is already stressed to limit or not :

In case the masonry is already stressed to the limit, then there will be no reserve strength left for accommodating the peak vertical stresses demanded by composite action.

(g) Reinforcement in lintel :

Normally, this is not a controlling factor. If the area of reinforcement provided is extremely low and the masonry above is comparatively strong. failure of composite action by yielding of reinforcement could be expected.

Studies Carried out

Brick strength, mortar proportion and height of masonry above lintel were the three para meters of the study carried out at the Institute. Bricks having three different strengths, viz., 3 N/mm^2 4 N/mm^2 and 6 N/mm^2 approximately were used in the tests The cement : sand mortar proportions used in the tests were 1:6 and while 1:8 the height of masonry above the lintels was kept as 30 cm and 45 cm. In all, twelve lintel masonry panels were made and tested. Uniformly distributed load was applied in stages on the panels. The strains, deflections and development of cracks were noted at each stage of loading, till the panels failed. Masonry cubes made alongwith the panels were also tested in a 100 tonnes capacity Universal Testing Machine to determine the stress-strain relationship for the stresses in the masonry panels for corresponding strains. The results of the studies are given below :

(a) Crack pattern and mode of failure :

The first cracks started at the top of the masonry above the edges of the opening and extended downwards and outwards at an angle of about 70° to the horizontal. The development of these cracks appeared to be mainly due to the intensity of shear stress developed in brick-work near edges of openings being more than the shear strength of brickwork. As the load was increased, cracks also extended and in almost all cases, the failure occurred by the extension of these cracks to the full depth of brick-work and separation of horizontal joint between lintel and brickwork near the supports. In all the tests, shear strength of brickwork governed the failure.

(b) Loads at first crack, failure and allowable working loads :

The ultimate load increased with the height of brickwork. For the same height, the load carrying capacity decreased with masonry strength. The load at first crack varied from 45% to 75% of the utlimate load.

The allowable load was calculated taking a factor of safety of 2 against load at first crack and a factor of safety of 5 against failure load. The present knowledge indicates that the load acting on a lintel in a multistoreyed load bearing wall is that from one storey above. The allowable loads were found to be more than the loads acting in cases, where the brick strength is not less than 3 N/mm^2, mortar is not leaner than 1:6 cement : sand mortar and the height of brickwork above lintel is not less than 45 cm.

(c) Comparison of failure loads :

The actual failure loads were found to be 1.6 to 2.6 times the ultimate load computed for the panels, considering them as reinforced brick beams. This indicates that at least part of the load is transmitted by arch action.

(d) Variation of vertical and horizontal stresses in panels :

The average vertical compressive stress developed adjacent to the supports of lintels were found to be 1.75 times the uniformly applied stress. In general, the horizontal stress intensity was found to be more than half the vertical stress intensity.

(e) Deflection :

The maximum deflection recorded at the penultimate stage of loading was found to be 1 in 232 to 1 in 381 of the span. This variation in deflection is due to difference in strength and height of masony above lintel.

(f) Stress developed in reinforcement :

The stress developed in the reinforcement even at the failure stage was found to be less than the permissible stress in steel. This indicates that a major portion of the load is transferred to the supports by arch action developed in the brickwork. The equivalent bending moment in lintel varied from WL/74.5

to WL/344 where W is the total load and L is the span. In general, panels having higher strength of masonry and more height showed lesser bending moments.

Conclusions

(a) There is composite action of lintel with brick-work above, even when the brick masonry is of low strength and the height of brickwork above lintel is 45 or 30 cm only.

(b) For a given masonry, the load carrying capacity increases with increase in the height of brickwork above lintel.

(c) For a given height of brickwork, the load carrying capacity increases with strength of masonry above lintel.

(d) When the height of brickwork above lintel is less than 0.37 span and the masonry is of low strength, failure occurs by shearing of masonry over supports.

(e) Compared to deep panels, vertical stress concentration in brickwork is less in case of shallow panels.

Recommendations

The composite action of lintel with brick-work above is governed by a number of parameters. The design of composite lintel is somewhat complicated and not easily amenable to calculation. For the ready use of site engineers, design chart for thin precast lintels in brickwalls of normal residential buildings is given in Table 1. It is applicable only when the load on the composite lintel is a uniformly distributed one. The brickwork over the lintel shall be not less than 45 cm in height and shall be constructed in a mortar not leaner than 1:6 cement : sand mortar. Thin lintels shall not be used in brickwalls made in mud mortar. It shall be noted that there is no composite action in continuous lintels at intermediate supports, where the top portion of the lintel is in tension.

The thickness of the lintel shall be the thickness of the brick i e. 7 cm in case of modular bricks and the lintel shall preferably have a bearing of 23 cm/20 cm on either supports. Details of a thin precast lintel in a single brickwall over an opening of span 120 cm is shown in Fig. 1.

Table 1

Design Chart for Thin Precast R.C.C.

Maximum clear span of opening (cm)	Width of lintel (cm)	Minimum crushing strength of brick In wall (N/mm^2)	Main reinforcement
120	20/23	4	2 Nos. 10 mm dia. m.s. bars,
120	10/11.5	4	2 Nos. 10 mm dia. m.s. bars.
120	30/35	4	3 Nos. 10 mm dia. m.s. bars.
150	20/23	7	2 Nos. 10 mm dia. m.s. bars.
150	10/11.5	7	2 Nos. 10 mm dia. m.s. bars.
150	30/35	7	3 Nos. 10 mm dia. m.s. bars.
180	20/23	10	2 Nos. 12 mm dia. m.s. bars.
180	10/11.5	10	2 Nos. 12 mm dia. m.s. bars.
180	30/35	10	3 Nos. 12 mm dia. m.s. bars.

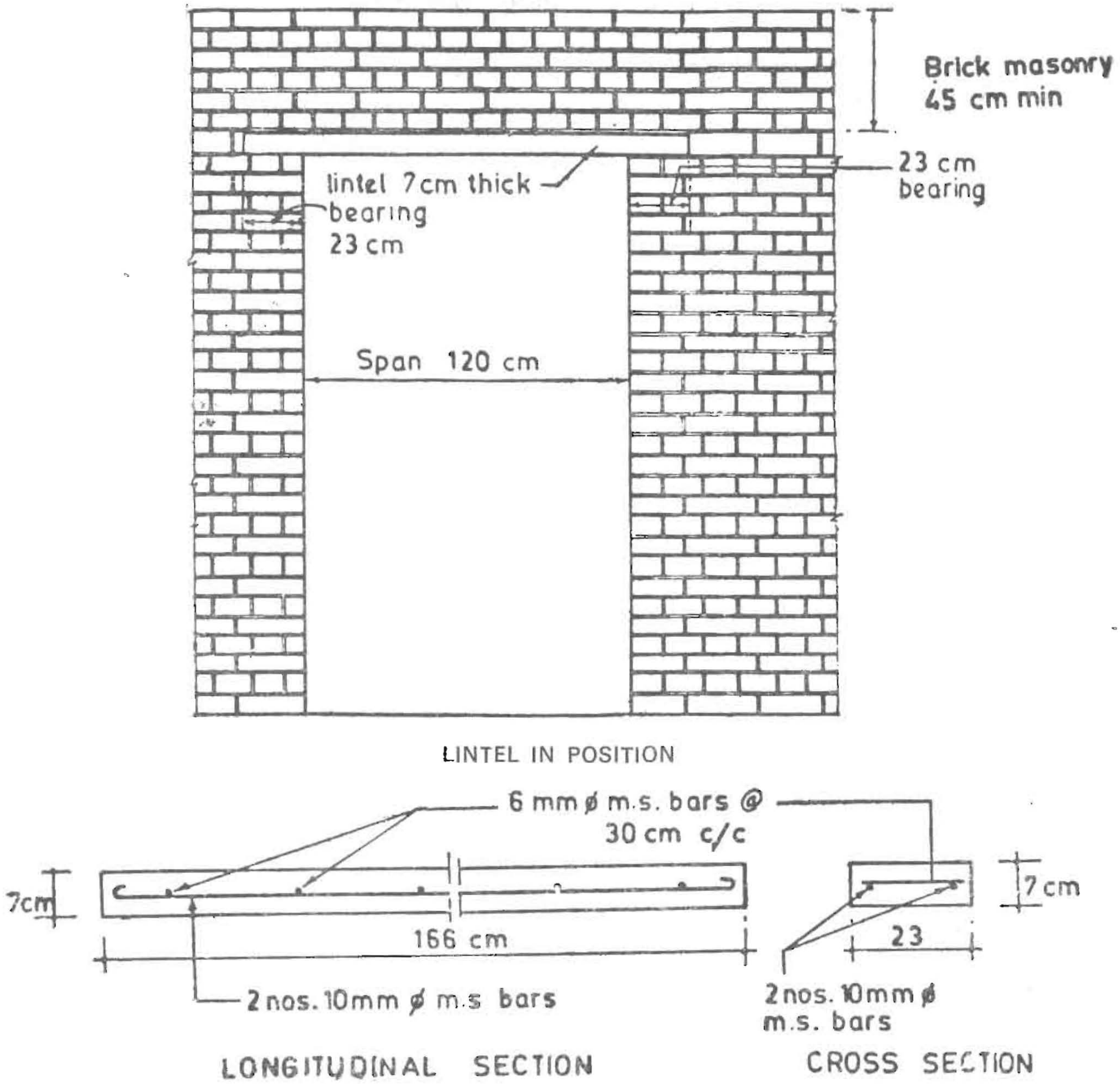

Fig. 1. Details of a Thin Precast Lintel

Lintels can be cast over a concrete topped casting platform, finished level and smooth after applying a coat of used engine oil or any other bond-breaking material. Simple timber/steel mould duly oiled can be used for the casting, The main reinforcement as given in Table **1** shall be placed at the centre of the thickness of the lintel and 6 mm dia m.s. distribution bars shall be spaced @ 30 cm c/c above the main reinforcement and tied with it with G.I. wires. The concrete used shall be of grade M 15 with coarse aggregate of 20 mm and down size and shall be compacted by vibrators. The top of the lintels shall be finished rough with chequered lines while the bottom and sides shall be finished smooth. The lintels shall be water cured for two weeks and air dried for another two weeks before using them in any construction. During construction, in case the lintels are not resting on door/window frames, they shall be supported to a length of 30 cm at the midspan, before the wall above is built and for at least a week's time after the wall is completed.

In case, the lintel is having a chajja projection, both may be precast together. A detail of lintel with chajja is shown in Fig. 2. Alternately, the lintel portion may be precast with the reinforcement for the chajja projecting out. The chajja portion can be cast-in-situ. In either case, the chajja projection has to be kept propped up till the wall above is built to provide sufficient counterweight against overturning.

Where two lintels cross each other at the bearing portion, the lintels may be precast upto the bearing portion only with the reinforcement for the bearing portion exposed This portion shall be cast-in-situ. Alternately, both the lintels may be cast completely insitu. Lintels have to be kept propped in either case, till the concrete and masonry attain strength.

Advantages

Use of pracast lintels speeds up the construction of walls, besides eliminating shuttering and centering. Adoption of thin lintels results in about 50 per cent saving in materials and overall cost, compared to lintels based on conventional designs.

Material and Labour Requirement

The labour and material for casting, curing. site transportation, hoisting and placing in position thin precast lintels 23 × 7 cm for a clear span of 120 cm and lintel-cum-chajja for the same span with a chajja projection of 45 cm are given below. From this basic data, knowing the rates for labour and materials, the cost of the lintel and lintel-cum-chajja can be worked out for any place. Contractor's profit and overheads are to be added.

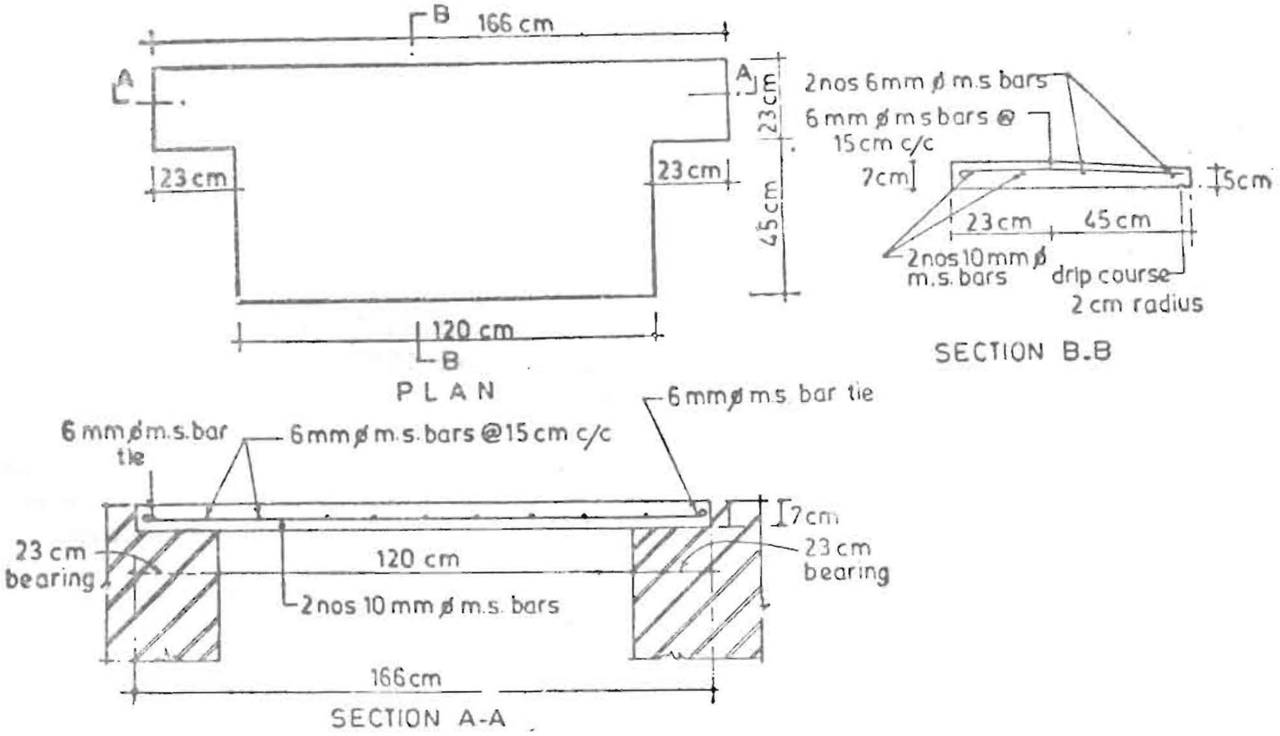

Fig. 2. Details of a Thin Precast Lintel with Chajja

I. Lintels (Fig. 1.)—10 Nos.

(a) Casting and Curing

Mould casting platform, mould oil, vibrator etc. (L.S.)	Rs. 10.00
Cement	1.7 bags
Coarse sand	0.13 m^3
20 mm and down coarse aggregate	0.26 m^3
Water charges and T. & P. (L.S.)	Re. 2.00
Mild steel	24 kg.
Mason	0.4 mandays
Bar Bender	0.25 mandays
Mazdoor	0.8 mandays

Add 1% for breakage of the lintels

(b) Site transportation, hoisting and placing

Mason	0.1 mandays
Mazdoor	0.6 mandays
Scaffold charges etc. (L.S.)	Rs. 5.00

II. Lintel-Cum-Chajja (Fig. 2.)-10 Nos.

(a) Casting and Curing

Mould, casting platform, mould oil, vibrator etc. (L.S.)	Rs. 20.00
Cement	3.8 bags
Coarse sand	0.29 m^3
20 mm and down coarse aggregate	0.58 m^3
Water charges and T.&P. (L.S.)	Rs. 3.00
Mild steel	42 kg.
Mason	0.6 mandays
Bar Bender	0.4 mandays
Mazdoor	1.2 mandays

Add 2% for breakage of the units

(b) Site transportation, hoisting and placing

Mason	0.1 mandays
Mazdoor	1.2 mandays
Scaffold charges etc. (L.S.)	Rs. 10.00

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