METHOD OF FORMING JOINT CONSTRUCTION OF PRECAST CONCRETE COLUMNS AND BEAMS

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Filed: May 18, 1973

Foreign Application Priority Data
May 18, 1972 Japan

U.S. Cl. 52/744, 52/252, 52/259, 52/263, 52/726

Int. Cl. E04b 1/04

Field of Search 52/260, 251, 252, 259, 52/263, 250, 432, 253, 258, 722, 726, 744

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A construction method of rigid structural joints between precast concrete columns and beams by utilizing two sets of jointing systems in combination. In vertical direction columns are jointed by placing steel sleeves within joint panel zone wherein protruding main bars from upper and lower columns are inserted and grouted by non-shrink mortar giving structural continuity. In horizontal direction beams are jointed by formation of U-shaped grooves at beam ends wherein main reinforcing bars are enclosed and lap jointed to preassembled main bars placed inside of aforesaid grooves by casting concrete within the grooves.

2 Claims, 19 Drawing Figures
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METHOD OF FORMING JOINT CONSTRUCTION OF PRECAST CONCRETE COLUMNS AND BEAMS

The present invention is generally concerned with construction methods of rigid structural joints between precast columns and beams in prefabricated building construction, and more particularly relates to the use of steel bar splice sleeves at the joint panel zone for column-to-column joint, and the use of U-shaped beam ends in which main bars are cast in and lap-jointed to the pre-assembled bars for beam-to-beam joint, the use of the two jointing methods being combined into one integrated system.

One of the most important questions encountered in the construction of prefabricated concrete structure of column and beam type is the formation of structural joints between the prefabricated elements. According to the normal practice, for structural reasons such joints are generally positioned where the stresses under loads are relatively small, i.e., at the mid-span for the beams and mid-storey height for the columns, similar to the normal practice in steel frame construction.

However, this structural advantage is turned into severe disadvantages as far as the manufacturing, handling, and site operations of such elements are concerned, because the elements thus formed generally have highly complicated three-dimensional forms particularly where the beams are deployed in two directions for the structural reasons arising from earthquake resistant design. In addition, such elements become rather heavy and unstable during erection, thus needing much temporary supports to be held up safely in position.

Furthermore, the column joint formed at mid-storey height presents problems in architectural finishes, as it may easily come close to the level of vision of the users or the residents of the building when occupied.

Another important question in the construction of structural joints in prefabricated concrete building is the provision of tolerances and the simplification of jointing operation. As an inherent nature of concrete construction, it is not possible to achieve the accuracy in jointing parts comparable to that of steel frame construction. Therefore, the use of welding and bolting in the jointing operation is not desirable for structural as well as for economical reasons. On the other hand, if the jointing operation may be performed only through the grouting and the concreting operation, utilizing the bonding effect of reinforcing bar to mortar or concrete, it will result in much simplicity and economy, and will also provide adequate tolerance necessary for this type of construction, and at the same time will achieve structural continuity and monolithic character inherent to the reinforced concrete construction.

The instant invention has been accomplished while taking the abovementioned technical circumstances into consideration.

A primary object of the invention is to achieve the simplest possible shapes of linear nature for the precast columns and beams in order to facilitate mass-production, transportation, and handling of such prefabricated structural elements.

Another object of the invention is to achieve simplicity in site operation of the jointing of the structural elements through the elimination of welding and bolting as well as the use of falsework.

A further object of the invention is to conceal the structural joints which tend to result in an inferior architectural effect into places where the occupants or the users of the building may not see easily.

Another significant object of the invention is to achieve full continuity and rigidity of the structural joints at least comparable to those of normal reinforced concrete construction, wherein the joints are made monolithic through the utilization of bonding between the reinforcing bars and the concrete.

The objects of the invention are achieved through the provision of structural joints in or adjacent to the joint panel zone. The column-to-column joint is formed by providing steel splice sleeves within the joint panel zone, wherein protruding main reinforcing bars from upper and lower precast columns are inserted and locked, upon the hardening of non-shrink mortar grouted inside the sleeves, through the bonding and wedging effect of the bars, mortar, and the sleeves which are slightly tapered towards the top and the bottom of the length. (A reference is made to the U.S. Pat. No. 3,540,763 for the principle of the steel splice sleeve). Said bars are of deformed type and the interior walls of the sleeves are finely grooved.

The beam-to-beam joint is formed through the lapping effect of the beam main bars which are cast within the U-shaped groove at the beam ends and the pre-assembled main bars which are projecting from the joint panel zone into the said groove upon the hardening of concrete poured within the said groove. The U-shaped groove is given an adequate length to ensure full structural continuity between the jointed elements through the bonding of said groove, bars, and concrete, further secured by the stirrup bars precast within the U-shaped groove and bent down over the pre-assembled bars prior to the concreting. No or little falsework is necessary for the concreting operation as the said U-shaped groove itself functions as a formwork. Full sectional area of the joint becomes structurally effective after the jointing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1, 2, 3, 4, 5 and 6 are sectional views showing various embodiments of this invention;

FIGS. 7 and 8 are plan and elevation of a precast column respectively;

FIGS. 9 and 10 are plan and elevation of a precast beam respectively;

FIG. 11 is a plan of a pre-assembled reinforcing bars;

FIGS. 12, 13, 14, 15 and 16 are sectional views showing the sequence of construction procedure;

and FIGS. 17, 18 and 19 are sectional detail of a joint panel zone, taken along the lines I—I, II—II and III—III in FIGS. 18 and 17 respectively.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, there is illustrated, in FIGS. 1 through 6, an outline of various embodiments in accordance with this invention.

Basic elements with which the structural joint is formed according to this invention comprise a precast reinforced concrete column 1, a precast reinforced concrete beam 2, and a sleeve 3 serving as a connector to reinforcing bars projecting from the column.

As shown in FIG. 1, an end portion of a beam 2, which is formed with a groove 4 of a U-shape in section, is positioned on a lower column 1. A sleeve 3 is
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so positioned in a joint panel zone that the opposed open ends thereof align with the reinforcing bar 5 of the column. The bar 5 extending from an upper end of a lower column 1 is inserted in the sleeve 3. A set of pre-assembled bars 6 is set in a space formed by the two grooves at the ends of right and left beams. Then an upper column 1 is so placed on the lower column 1 that the bar 5 extending from the lower end of the upper column 1 is inserted within the sleeve 3, followed by filling the interior of the sleeve with a grouting material to lock the bars 5 of the upper and lower columns to each other. Said space formed by the two grooves and extending across the ends of both columns is filled with concrete to make the columns and beams monolithic.

As seen in FIG. 2, a sleeve 3 can also be embedded within a precast concrete block 7 to be put in position at a joint panel zone, leaving its upper and lower ends open on the surface of the block. The block is provided with a reinforcing bar 6 extending laterally.

Both upper and lower columns 1 and 1 are jointed together by bars 5, 5 by means of the sleeve, in which a grouting material is subsequently poured. A beam 2 is made monolithic with respect to the columns by concrete poured in a groove 4.

FIGS. 3 through 6 show the use of a sleeve embedded in a central point along the length of a beam.

In FIG. 3 there is shown a sleeve 3 which is embedded in a central point along the length of a precast concrete beam 2, leaving upper and lower openings of the sleeve on the top and bottom surfaces of the beam. The beam 2 is formed with a groove 4 of a U-shape in section at one end thereof, and provided with a projecting bar 6' at the other end thereof. One beam 2 is arranged to the other beam 2 in butt joint or face to face relationship at a middle point along the span between columns 1 and 1, with the setting of the projecting bar 6' in the U-shaped groove 4, and the groove 4 is filled with concrete, to join the beams 2 and 2 at a middle point between the columns.

FIG. 4 shows a manner of jointing wherein a sleeve 3 is embedded in a central point along the length of a precast beam 2, the beam is formed with a U-shape groove 4 at both ends thereof, said beam 2 is arranged on column 1 in a butt joint relationship with the other beam at an intermediate point between columns 1 and 1, a bar 6' is set in the groove, and concrete is poured therein.

FIG. 5 shows a manner of jointing wherein a sleeve 3 is embedded in a precast concrete beam 2 at a portion central along the length thereof, the beam is provided with a U-shape groove or channel at both ends thereof, a precast concrete beam 2 to be used in the intermediate zone between columns is provided with a projecting bar 6' at both ends thereof, said bars 6' and 6' are set in the U-shape grooves 4, and concrete is poured in the grooves.

FIG. 6 shows a case where the outline of framing takes a T-shape configuration by the provision of a wall panel or column 8, the top of which is jointed to the bottom surface of a reinforced concrete beam 2 carrying a sleeve 3 embedded therein. The column 8 and beam 2 may be manufactured separately and assembled in the building site.

FIGS. 7 and 8 show details of a column 1. The column 1 may be either circular, square, or cruciform in section, is provided with bars 5 projecting from the top and bottom thereof, and is formed with a dent 9 and a corresponding projection 10 on the top and the bottom thereof, respectively.

FIGS. 9 and 10 show an example of a precast beam. The beam 2 is formed with a U-shape groove 4 at the both ends thereof. In some cases, the beam is provided with a sleeve embedded therein at a portion central along the length thereof, and the sleeve is used for jointing a wall panel or column 8 to the top and/or bottom of the beam 2. A dent 11 receives a projection formed on the bottom of a column 8 joined to the top of the beam 2. On a lateral side wall 12 of the U-shape groove 4 there are mounted several stirrups 13.

FIG. 11 shows an example of pre-assembled bars 6 extending from a joint panel zone into the U-shaped grooves 4 of the precast beams 2.

FIGS. 12 through 16 show the sequence of construction procedure. First, a column 1 is erected, a beam 2 is disposed on the top of the column (see FIGS. 12 and 13), a set of preassembled bars 6 is set in a groove formed by the column 1 and U-shape groove 4 of the beam 2 (see FIG. 13), sleeve 3 is put in position through which a bar 5 projecting from the lower column 1 is inserted, stirrups 13 are bent over the pre-assembled bar 6 (see FIG. 14), the U-shape groove 4 is filled with concrete 16 (see FIG. 15), a bar 5 projecting from the lower end of an upper column 1 is introduced into the sleeve 3 after hardening of the concrete, and a grouting material is poured within the sleeve 3 (see FIG. 16). The foregoing procedure is repeated until a desired number of stories are constructed.

FIGS. 17, 18, and 19 show details of a joint panel zone. Four pairs of bars 5 projects from a cruciform column 1 (one pair through each flange), four beams 2 whose ends are of U-shape configuration in section are placed in the four directions. A set of pre-assembled bars 6 consisting of bars 14 held in position by additional bars 15 is put in position in the U-shape groove. Stirrups 13 are arranged around main bars 17 of a beam which are cast in the walls of the U-shaped groove, and concrete is poured after the parts of the stirrups projecting out of the precast beam are bent down over the pre-assembled bars 6.

Each sleeve 3 is secured in position by connecting bars 18. Non-shrink mortar 19 is subsequently poured within the sleeve 3. The sleeve 3 is to be tapered towards the top and the bottom thereof and have two openings of a minimum diameter at the ends thereof. The bars 5 are to be of a deformable type.

What we claim is:

1. A method of constructing rigid structural joints between precast concrete columns and beams by utilizing splice sleeves of almost the same depth as the beams, said method comprising the steps of:
   a. vertically positioning a lower column having reinforcing bars extending from the upper end thereof;
   b. positioning a sleeve on the lower column in such a fashion that the opposed open ends thereof align with the reinforcing bars of the columns;
   c. inserting the reinforcing bars in the sleeve;
   d. positioning the end portion of a first beam formed with a groove which is U-shaped in cross section on the lower column;
   e. positioning the end portion of a second beam formed with a groove which is U-shaped in cross section on the lower column;
f. placing a set of pre-assembled bars in the space formed by the two grooves in the first and second beams; then

g. placing an upper column having reinforcing bars extending from the lower end thereof on the lower column in a fashion such that the reinforcing bars extending from the lower end thereof are inserted within the sleeve; then

h. filling the interior of the sleeve with a grouting material to lock the reinforcing bars from the upper and lower columns to each other; and

i. filling the space formed by the two grooves and extending across the ends of both columns with concrete in order to make the columns and beams monolithic.

2. A method of constructing rigid structural joints between precast concrete columns and beams by utilizing splice sleeves of almost the same depth as the beams, said method comprising the steps of:

a. vertically positioning a lower column having reinforcing bars extending from the upper end thereof;

b. positioning a precast concrete block having:

i. a sleeve embedded therein with its upper and lower ends open on the surface of the block and

ii. a reinforcing bar embedded therein and extending laterally therefrom on two sides on the lower column in a fashion such that the reinforcing bars of the lower column are inserted in the sleeve;

c. positioning the end portion of a first beam formed with a groove which is U-shaped in cross section on the lower column with the reinforcing bar embedded in the block extending into the groove;

d. positioning the end portion of a second beam formed with a groove which is U-shaped in cross section on the lower column with the reinforcing bar embedded in the block extending into the groove;

e. placing an upper column having reinforcing bars extending from the precast end thereof on the lower concrete block in a fashion such that the reinforcing bars extending from the lower end thereof are inserted within the sleeve; then

f. filling the interior of the sleeve with a grouting material to lock the reinforcing bars from the upper and lower columns to each other; and

g. filling the space formed by the two grooves and extending across the ends of both columns with concrete in order to make the columns and beams monolithic.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,867,805
DATED : February 25, 1975
INVENTOR(S) : Yuzo MIKAMI et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE HEADING:

Under Foreign Application Priority Data add the following:

May 12, 1973 Japan 52731/73

Signed and sealed this 29th day of April 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

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