

A JOINT BETWEEN BEAM ELEMENTS AND COLUMN ELEMENTS MADE
OF PREFABRICATED REINFORCED CONCRETE

The present invention basically relates to the sector of prefabricated buildings, and in particular regards a new type of joint between beam and column elements made of prefabricated reinforced concrete, characterized by a great ease of laying *in situ* and provision of the formwork in which the concrete for completing the joint itself is poured.

Currently, there exists a type of beam-column joint that may seem similar to the joint according to the present invention, in so far as the beam is equipped with lateral end shoulders for lateral containment of the casting of the concrete that constitutes the joint, but the main difference lies in the fact that – in the known case – the current cross section of the beam is defined by the extrados of the shoulders, without any narrowing of section of the beam outside the joint.

Another type of beam-column joint is also known, the main difference of which with respect to the joint forming the subject of the present invention lies in the fact that it does not envisage the shoulders, and the cast is entirely contained by the formwork purposely provided *in situ*. In this case, there exists an evident practical difficulty of supporting the beam element before casting, so much so that the only application that is known is in experiments aimed at establishing the effectiveness of the transfer of the stresses between the re-rods, by means of the U-shaped

configuration.

These different characteristics of construction, in addition to the differences of a geometrical nature, cause, especially in the first case of the known art, a substantial waste of concrete. Furthermore, in the cases referred to above it is difficult to position and support the beam conveniently during installation, and the joints that can thus be obtained do not enable restoring of the continuity of the frame in an economically advantageous way.

There is also known, from the document No. JP 2012 144936, a beam-column joint made of pre-fabricated reinforced concrete, in which - unlike the present invention - the re-rods are constituted by simple rectilinear lengths of iron having an anchorage head to be inserted in the joint through holes provided after installation of the beam on the column. Furthermore, unlike the present invention, in the joint described in the document No. JP 2012 144936 the pre-fabricated beam is closed on three sides at the joint, and hence there cannot be rods projecting from the column, but only rectilinear lengths of iron to be inserted in the joint afterwards.

A better understanding of the invention will be obtained from the ensuing detailed description and with reference to the attached drawings, which illustrate, purely by way of non-limiting example, a preferred embodiment.

In the drawings:

Figure 1A is a 3D view with the reinforcements

visible in through view, of the ends of a pre-fabricated beam and of a pre-fabricated column according to the present invention, during the step of constitution of the joint;

5 Figure 1B is a view, not of a see-through type, corresponding to the previous one;

Figure 2A is a see-through view from above of the stretches of beam and column of Figure 1;

10 Figure 2B is a view, not of a see-through type, corresponding to the previous one;

Figures 3A and 4A, corresponding to Figures 1 and 2 respectively, show in see-through view the beam and the column once assembly *in situ* of the joints is completed; and

15 Figures 3B and 4B are views, not of a see-through type, corresponding to the previous ones.

In structural terms, the characteristics of constraint that the joint guarantees are those of a perfect fixed joint.

20 In the preferred embodiment described herein, the joint is basically made up of:

1. a portion prefabricated with the beam T;
2. a portion prefabricated with the column C; and
3. a portion that can be completed *in situ*.

25 **1. PORTION PREFABRICATED WITH THE BEAM**

The beam in question typically has a rectangular section.

30 The section of the beam T outside the joint will be referred to in what follows as "calculation cross section".

According to a peculiar feature of the invention,

at the joint, the cross section of the prefabricated beam T widens gradually and then divides into two prismatic elements with narrow rectangular cross section, referred to hereinafter as shoulders S that
5 form an edge for containment (formwork) of the subsequent casting. In the space thus created, which according to the invention has the same cross section as the "calculation cross section", just the reinforcement is provided, made up of the longitudinal
10 horizontal rods 1, which end in a U, and of the brackets 2, which are temporarily set up against one another at the inner end of the beam T and then, after the beam has been placed *in situ* on the column C, are designed to be arranged around the horizontal
15 longitudinal rods 1 of the beam T and 3 of the column C, in their position predefined in the reinforced-concrete structural design stage.

The dimension in length of the compartment L depends upon the diameter of the reinforcement chosen
20 (Φ), as illustrated in Table 1 provided below.

2. PORTION PREFABRICATED WITH THE COLUMN

Provided on the column C, in the position where the beam T is rested thereon, is a continuity reinforcement made up of rods 3 bent to form a U
25 having the same diameter and position as the rods 1 projecting from the beam T but translated horizontally in a lateral direction with respect to the latter, just enough to enable interpenetration of this reinforcement 3 of the column C with the reinforcement
30 1 of the beam T, with the due constructional tolerances as illustrated in Figure 1. The rods 3 bent

to form a U projecting from the column C extend in length for a stretch LU from the extrados of the column C as defined in Table 1.

TABLE 1

Φ	L1	$L = L1 + 250 \text{ mm}$	$LU = L1 + 125 \text{ mm}$
<i>mm</i>	<i>mm</i>	<i>mm</i>	<i>mm</i>
20	540	790	665
22	590	840	715
25	670	920	795
28	830	1080	955
30	890	1140	1015
32	950	1200	1075

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The dimensions provided are valid for concrete for joints with $f'c = 49 \text{ MPa}$.

In the table:

LU is the extension of the rods or (or bars) 1 or 3 outside the column C or the beam T;

L1 is the length of interpenetration of the rods (or bars) 1 and 3; and

L is the length of the compartment that contains the reinforcement of the joint to be cast *in situ*.

To obtain the dimensions with different values of strength it is necessary to multiply L1 by the ratio $7/\sqrt{f'c}$ and update L and LU accordingly.

The column C also comprises means for temporarily supporting the prefabricated beam T during installation.

In the preferred embodiment described herein, said supporting means are constituted, purely by way of example, by a short cantilever M cast together with the column C, on which cantilever the shoulders S of the beam T are rested.

3. PORTION THAT CAN BE COMPLETED *IN SITU*

Once the beam T has been set in its final position, on the provisional supporting means constituted by the above cantilever M, the brackets 2 of the reinforcement are translated into their position envisaged in the structural design.

According to a further peculiar feature of the invention, the length of said cantilever M is such as to enable the operators to gain access to the compartment between the shoulders S also from beneath so as to facilitate the operations of positioning of the brackets 2 along said reinforcements 1 and 3.

Once the bottom of the compartment, confined in which are the reinforcements 1 and 3 and the corresponding brackets 2 of the joint, is closed, a provisional formwork is anchored to the shoulders S.

Casting is hence completed with a compensated-shrinkage self-levelling concrete, compounded with aggregate with a maximum grain size of 10 mm, preferably fibre-reinforced in the percentage of 0.5 vol%, the characteristic strength of which is equal to or higher than 1.65 times the characteristic strength of the concrete used for prefabrication of the beam.

Finally, it should be noted that the rods of the reinforcements 1 and 3 of the beams T and of the columns C may also not be curved to form a U and may be rectilinear and joined by joining means of a known type.

CLAIMS

1. A joint between beam elements (T) and column elements (C) made of prefabricated reinforced concrete, the joint comprising:

A) a portion prefabricated with the beam (T),
5 equipped with projecting reinforcement rods (1);

B) a portion prefabricated with the column (C),
equipped with projecting reinforcement rods (3),
which can be set alongside said reinforcement rods
(1) of the beam (T); and

10 C) a portion that can be completed *in situ*;

wherein the cross section of the prefabricated beam (T), at the joint, widens gradually so that it then divides into two prismatic elements with narrow rectangular cross section, referred to as shoulders
15 (S), which define a containment compartment, i.e., a formwork, for the subsequent casting; said containment compartment being accessible and open at the top, at the bottom, and at the front side facing the column (C), wherein said reinforcement rods (1 and 3) are
20 arranged in mutually parallel vertical planes, where the column (C) comprises means for temporarily supporting the beam (T) during installation, characterized in that the projecting reinforcement rods (1 and 3) are U-shaped and in that the length of the
25 means is such as to enable the operators to gain access to the containment compartment between the shoulders (S) also from beneath the containment compartment so as to facilitate the operations of positioning of the brackets (2) along said reinforcements (1 and 3) when
30 the beam (T) is positioned on the column (C) in its final, installed position.

2. The joint according to Claim 1, characterized

in that in the space between the shoulders (S), which has the same cross section as the beam (T) outside the joint, only one reinforcement is provided in the beam (T), said reinforcement being made up of longitudinal horizontal rods (1), which end in a U, and of brackets (2).

3. The joint according to Claim 2, characterized in that provided on the column (C), in the position where the beam (T) is rested thereon, is a continuity reinforcement made up of rods (3) bent to form a U, which have the same diameter and the same position as the rods (1) of the beam (T) but are translated horizontally in a lateral direction with respect to the latter, to enable this reinforcement (3) of the column (C) and the reinforcement (1) of the beam (T) to interpenetrate.

4. The joint according to Claim 3, characterized in that the rods (3) bent to form a U of the column (C) extend in length from the extrados of the column (C) for a stretch (LU) that is a function of the length of overlapping (L1) of the rods (1 and 3).

5. The joint according to Claim 4, characterized in that the means for temporarily supporting the prefabricated beam (T) during installation, is for example, a short cantilever (M) cast together with the column (C), said cantilever functioning as resting surface for the shoulders (S) of the beam (T).

6. The joint according to Claim 5, characterized in that said portion that can be completed *in situ* envisages that, for closing the bottom of the compartment defined by said shoulders (S) and by the short cantilever (M) in which the reinforcements (1 and 3) of the beam (T) and of the column (C) are confined,

as well as the corresponding brackets (2) of the reinforcement of the joint that are located in their position envisaged by the structural design, a provisional formwork is provided, which is anchored to the shoulders (S).

7. The joint according to Claim 6, characterized in that it envisages a completion casting with a compensated-shrinkage self-levelling concrete.

8. The joint according to Claim 7, characterized in that said concrete is compounded with aggregate of maximum grain size of 10 mm, preferably fibre-reinforced with a fibre content of 0.5 vol%, the characteristic strength of which is equal to or higher than 1.65 times the characteristic strength of the concrete used for prefabrication of the beam (T).

9. The joint according to Claim 8, characterized in that the dimension in length (L) of the compartment depends upon the diameter of the reinforcement chosen (Φ), as illustrated in the table below:

Φ	L1	L = L1+250 mm	LU=L1+125 m m
mm	mm	mm	mm
20	540	790	665
22	590	840	715
25	670	920	795
28	830	1080	955
30	890	1140	1015
32	950	1200	1075