



CONCRETE WALL WITH FORMWORK SERVING ALSO AS REINFORCEMENT

TECHNICAL FIELD

The invention refers to a wall made of concrete or similar materials built from a permanent unfolded formwork integrated in the wall and including two formwork walls placed face to face and connected by articulated connecting elements to the formwork walls by means of stiffeners attached to the formwork walls, the gauge between these formwork walls after being unfolded being filled in with a filler such as concrete.

The invention also concerns a method for building such a wall as well as a specially adapted formwork/reinforcement for the construction of this wall.

BACKGROUND OF THE INVENTION

To raise concrete walls, formworks that delimit a volume in which concrete is poured are typically used. Usually, these formworks comprise: two walls placed face to face defining between them an interval where concrete is introduced, and connecting devices holding the walls with the required gauge. For holding these walls, crossbars are used for example, whose ends support the formwork faces arranged one opposite the other and these crossbars being traversed by blocking pieces taking support on the external faces of the formwork walls.

When the concrete is set, the formwork is recovered and the blocking pieces are withdrawn. The crossbars submerged in the concrete, which no longer have any function, can be kept or withdrawn and do not take part in the strength of the wall, but on the contrary, make it more fragile.

It is essentially the quality of the concrete that confers the strength to the wall. To increase the strength of the wall with a classic formwork, horizontal and vertical reinforcements are introduced before the concrete is poured.

To increase the strength of a concrete wall, the use of permanent formworks whose water-proof or permeable walls constitute the skin of the wall is known. Mostly, these walls have waves that allow an anchorage of the skin in the concrete. This is thus known as collaborating formwork. The strength of the final composite structure built



in this way is a superposition of the concrete strength and that of the formwork that constitutes the skin.

These walls are linked locally one to the other thanks to crossbars traversed by recoverable blocking pieces or by fastenings whose ends anchor on said formwork walls. These fastenings extend essentially according to an orthogonal direction to the formwork faces. In this case, formwork walls and the fastenings that link them help in the reinforcement of the structure of the concrete wall. According to the type of fastenings, a thermal and a mechanic decoupling for both formwork walls can be obtained.

10 A formwork of the type described above is known of the patent FR-A-2 675 181. The articulated connecting elements allow the reduction of the number of assembly operations, and facilitate the setting of the formwork while keeping its strength and its conformity to security and manufacture standards, all this with a lightweight structure.

15 The document WO 97/31165 describes an improvement using a slender element bent in zigzag as articulated connecting element, which distributes the forces in the concrete, parallel to the external faces of the wall, so that a skin having a hoping effect is formed. Thus, the wall is reinforced.

20 However, with this known device, it seems necessary or desirable to include an internal reinforcement, which is difficult to make while the formwork is being manufactured. Thus, it is necessary, on the construction site, to insert manually separated stiffeners inside the formwork. This operation is expensive and time consuming.

DESCRIPTION OF THE INVENTION

25 One of the objectives that the invention aims to obtain is to further increase the strength of concrete walls obtained with this kind of formwork, especially by an internal reinforcement, in a simple way and suppressing or reducing the use of separated reinforcement elements to be installed on the construction site.

30 In relation to this, the object of the invention is a wall made of concrete or similar materials built from an unfolded formwork integrated in the wall and including two formwork walls placed face to face and connected by articulated connecting

elements to the formwork walls by means of stiffeners attached to the formwork walls, the interval between these unfolded formwork walls being filled by a filler such as concrete. The articulated connecting elements of this permanent formwork, after having served for a first time to facilitate the transport and the setting of the formwork, constitute, once the formwork is installed, an element of reinforcement increasing the strength of the wall.

According to the invention, at least one of the formwork walls includes a concrete, mortar or similar surcharged casing in relation to the stiffeners and to the articulated connecting elements, this casing being arranged outside and/or inside the formwork wall. The stiffeners and the articulated connecting elements also constitute an inner reinforcement of the wall, submerged in the wall and covered by said casing. The thickness of this casing is preferably of at least 2.5 cm.

Furthermore, unlike the walls according to WO 97/31165 and FR 2 675 181, the formwork walls (or at least one of them) do not constitute any more the skin of the wall, but are submerged within the wall by said casing, in such a way to constitute also an internal reinforcement of the wall, which increases considerably the reinforcement or "hoop" effect.

The casing of these three elements (stiffeners, articulated connections and formwork walls) allows the reduction, i.e. to suppress, the need for inserting separated stiffeners on the construction site before pouring the concrete.

The casing constitutes an integral part of the wall, solidified at the same time that the filler, thus forming a wall in which the formwork is submerged. This formwork serves therefore at the same time as reinforcement.

The steel parts of the formwork - stiffeners, articulated connecting elements and expanded metal of the walls- are thus coated with a concrete/mortar thickness preferably of at least 2.5 cm being part of the wall. This will allow then the inclusion of these elements in the calculation of the wall strength and, furthermore, the reduction, i.e. suppression, in some cases, the steel quantities to be added in the formwork. On the other hand, the casing of these parts will allow the use of a non-galvanized steel in the manufacture of the formwork, being in this way less expensive.

The invention also concerns a method for building such a wall by means of a formwork including two formwork walls placed face to face and connected by articulated connecting elements to the formwork walls by stiffeners attached to the formwork walls, these connection elements allowing the walls to be kept either with a gauge defining an interval intended to receive a filler such as concrete, or folded for storage and transport.

According to the invention process, the formwork walls are unfolded and the interval between the unfolded formwork walls filled with the filling material, and:

- either, before the setting of the filler, on the external face of at least one formwork wall, a layer of mortar or similar is applied, so as to coat the formwork wall with a surcharge preferably of at least 2.5 cm,
- or a formwork, in which at least one formwork wall is attached but spaced from the stiffeners and the articulated connecting elements, is used, and the filling material such as concrete is poured, in such a way to coat the stiffeners and the articulated connecting elements with an adjacent thickness to the formwork wall, also preferably of at least 2.5 cm.

The stiffeners, the articulated connecting elements and the formwork wall itself when it is coated, constitute therefore a reinforcement inside the built wall, submerged in the wall and covered by said casing.

The invention also concerns a folding formwork of the type described above. The formwork according to the invention is characterized in that the articulated connecting elements of at least one formwork wall are articulated to the stiffeners with a gauge in relation to the formwork wall, preferably of at least 2.5 cm. These stiffeners are attached to the formwork wall by spacing means so that, when the interval between the formwork walls is filled by a filler such as concrete, the wall built in this way includes a surcharged casing in relation to the stiffener and to the articulated connecting elements, as described above.

The articulated connecting elements can comprise slender elements bent sensibly in zigzag, as described in document WO 97/31165. Each slender bent element (also called connections in Z) includes staggering opposite parts linked by means of

connecting - rods inclined in the opposed sense at both sides of each opposite part. The opposite parts alternated by all the slender connecting elements are aligned in a parallel direction one to other and are articulated to the walls, preferably by attachment means allowing only one degree of rotation liberty around the articulation axes formed by said opposite parts. These connecting elements in zigzag results on the filler, both:

- on one hand, compression forces oriented perpendicularly to the formwork faces, and
 - on the other hand, compression forces oriented sensibly in a parallel direction to the external faces of said wall so as to create a skin exercising a hooping effect whose efficiency is increased thanks to their form and their particular arrangement assuring the distribution of the forces within the above described wall, especially in that the connection elements and the stiffeners constitute a reinforcement submerged inside the wall.
- Other characteristics of the invention are shown in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be well understood with the aid of the description hereinafter, intended as a non-limiting example, with reference to the drawings that represent schematically:

- Figure 1: a top view of a wall according to the invention including an enclosed permanent formwork; and
- Figures 2 and 3: similar views of two other embodiments of the wall according to the invention.

PREFERRED EMBODIMENTS

- In reference to the drawings, it can be seen that in order to build a concrete wall, a permanent collaborating formwork is used. Traditionally, this formwork includes two formwork walls keeping the required gauge by means of an articulated connecting

device 1 including two "connections in Z", one shown with a black line, the other with a dotted line.

5 This connection device 1 is articulated to each formwork wall 8 by means of vertical stiffeners 2 consisting of profiles with the shape of a U or others. This articulation allows the walls 8 to be kept, either with a required gauge (as shown in the Figures), or folded for the storage and transport, thus facilitating the installation of the formwork.

10 In relation to this, connection devices 1 include straight opposite parts which extend sensibly in a parallel plane to the formwork faces along a predetermined length and preferably equal to the width of the stiffener 2 in order to bind in translation the connection device 1 with the stiffener 2.

15 These formwork walls 8 will advantageously comprise a lattice whose meshes are intended to evacuate exceeding water in the concrete. It may be iron panels or other expanded metals provided with horizontal reinforcements in V, or a lattice made in non-metallic composite materials completed by horizontal reinforcements in V. The stiffeners 2 are for example fixed on the walls 8 with the aid of hooking lugs 5, especially folded or bored, or by any other means (crimping, embossing, electric welding, etc.)

20 As known of the document WO 97/31165, these articulated connection devices 1 result, on the filler, both in compression forces perpendicularly oriented to formwork faces 8, and in compression forces sensibly oriented in a parallel direction to external faces of the wall so as to create a skin having a hoop effect.

25 The connecting elements 1 thus constitute a hoop in the concrete. So, when filling the space between the walls 8 with a fluid material (concrete for example), this results in a hydrostatics pressure so high as the permeability of the walls 8 is weak. This pressure operates traction forces on the walls 8 which determine by reaction, traction forces in the connecting pieces 1, and longitudinal compression forces in the wall 8.

30 These stresses are maintained until the hardening of the filler 7. It acts as a pre-stress device. After the setting, any overcharge on the wall determines a pressure in

the concrete or other filler 7. This pressure engenders, in the filler 7, compression stresses in the sense where this pressure is applied, but generally traction stresses in a perpendicular sense to this direction.

Concrete being a material that does not resist traction stresses, the connecting
5 device 1 allows this difficulty to be avoided. In fact, traction forces applied on the concrete 7 and in a perpendicular sense to the walls 8 lead to a stability by reaction of the traction forces in the connecting piece 1 and, by decomposition, a tangential compression force and in parallel to the walls 8.

Because of the anchorage of the walls 8 in the concrete 7 by means of stiffeners 2
10 and of the articulated connecting device 1, it is the assembly of the concrete 7 situated between the stiffeners 2 that is submitted to compression stresses. Thus, the device 1 allows the considerable modification of the distribution of the stresses inside the walls, when charging the latter. In fact, the higher the pressure resulting of the charge exercised according to a longitudinal axis, and the higher the
15 compression stress on the skin 8, the more the hoop effect will increase.

However, this hoop effect acting on the walls 8 as external skin can be insufficient, this is why in the practice up to now the use of reinforcements inserted in the unfolded formwork before pouring the concrete has been needed. That is why, according to one of the axes of the invention, after pouring the concrete 7 but before
20 it sets, at least one external face of the walls 8 is covered by a projection (guniting for example) of a layer of mortar 11 of a thickness of about at least 2.5 cm. These external layers 11 increase in a significant way the thickness of the wall (that is to say of the concrete) so that the stiffeners 2, or other reinforcement elements, the connecting device 1 and the formwork wall are coated by the concrete, and can be
25 included in the strength calculation of the wall.

This or these external layers 11 thus constitute an integral part of the concrete wall reinforced by the internal reinforcement. This or these layers 11 distinguish thus from a simple finishing coat, of plasters for example, without a structural role. On the other hand, these external projected mortar layers 11 can also serve as finishing coat.
30 Furthermore, the casing of the formwork by of the concrete/mortar allows the use of a non-galvanized steel in the manufacture of the formworks, thus less expensive.

According to another axis of the invention disclosed in Figure 2, the wall includes a first wall 8 in expanded metal and a second non-hemstitched wall 10 comprising a finishing panel. The connecting device 1 is articulated to the wall 8 by stiffeners 2 fixed by hooking lugs 5 or other devices, as for Figure 1. On the side of the panel 10,
5 the connection device 1 is articulated to stiffeners 2 attached to the panel 10, but separated from this by means of holds 13 attached by screws 3. These screws 3 extending beyond the stiffeners 2 to anchor in the concrete 7. The screws 3, or other hooking pieces, especially bored metal sheets, will be coated by the concrete 7.

When the concrete, or other filler, is poured between the walls 8,10, the hemstitched
10 wall 8 allows the evacuation of exceeding water, whenever the wall 10 is water-proof. As before, the wall 8 can be covered by a guniting projection of a mortar layer 11 of a thickness of about 2.5 cm. On the wall 10 side, the concrete, or other filler, forms a thickness 12 of at least about 2.5 cm between this wall 10 and the stiffeners 2 and the corresponding parts of the connections in Z.

15 Therefore, in this example, on both sides of the wall, the stiffeners 2 and the connecting device 1 forms reinforcement submerged by the thicknesses 11,12, thus situated within the wall. This embodiment is particularly advantageous since it allows an internal wall ready to use to be directly obtained, and thus avoids the supplementary cost of a finishing coat.

20 A third axis of the invention is disclosed in Figure 3. The wall is similar to that of figure 2, but includes two perforated walls 8,8' and, furthermore, an insulating panel 4, for example in polyurethane or in rock wool or other insulating or fire-proof material, adjacent to the wall 8' which forms the external face of the wall. On this side, the connecting device 1 is articulated to the stiffeners 2 attached to the panel 8'
25 but separated from this one by means of holds 13 attached by screws 3, or other hooking means, which extend beyond the stiffeners 2.

On the wall 8' side, the concrete 7, or other filler, forms a thickness 12 between the internal face of the insulating panel 4 (which has a formwork panel effect) and the stiffeners 2 with the corresponding parts of the connections in Z. According to a first
30 embodiment, the length of the holds 3 is defined in that a space between the insulating panel 4 and the stiffeners 2 forms a thermal decoupling. According to

another embodiment, the holds 3 are defined in such a way that the insulating panel 4 is held on the stiffeners 2.

5 This embodiment has the supplementary advantage that the insulating panel 4 is included in the folded formwork, which allows a worth time gain during the building, because once the concrete is poured, it will no longer be necessary to come back and add the insulation. As for the previous embodiment, the stiffeners 2 and the connecting device 1 forms reinforcement submerged by a thicknesses 11,12, thus situated within the wall.

10 The walls illustrated in Figures 1, 2 and 3 all have an increased strength comparable to that which would be obtained in a traditional wall by adding between the impervious formworks reinforcement elements such as iron bars. But their construction according to the process of the invention is simpler, faster and less expensive.

15 Furthermore, the use of mortar layers 11 projected by guniting allows, in the case that any less resistant filler than the concrete is used, compensation for the lack of strength of the wall.

When placing the formwork, there is a possibility to integrate the reserves (electricity and sanitary pipes).

20 The wall is obtained with the aid of several elementary formworks of the type described above arranged side by side. To assure continuity in the transmission of the forces and take advantage of the inertia of the totality of the wall, the length of the connections in Z is longer than the length of the formwork panel along which it extends, so that the end of an exceeding panel can hook on a contiguous panel.

25 At least certain connections in Z will be eventually provided with heating elements (not shown) such as thermistors to form a radiant wall. The use of the thermistors allows the emission of heat by creating a potential difference between the formwork walls.

Usually, the part of the connections in Z is fixed on the formwork wall 8,10 by attachment means in rotation with only a liberty degree around a parallel axis at the

plane of the formwork faces, perpendicularly to the vertical axis of the stiffeners 2 and excluding any other liberty degree.

As a variant, instead of having straight parts, the articulated parts of the connecting elements 1 may be angled, and articulated in the middle of a vertical stiffener of the type disclosed 2 or of a reduced size, or articulated behind the vertical stiffeners in a wedge shape.

Instead of stiffeners 2 in the form of a U piece, this reinforcement could advantageously be constituted by simple iron bars as those used for concrete reinforcement. These bars would be attached to formwork walls by spacing pieces for example.

To assure an acoustic and mechanic decoupling, attachment of the connection devices 1 on the formwork walls 8,10 can be done with elastic materials such a rubber.

To improve the transmission of forces, the highest point of the waves of the slender element 1 bent in zigzag are attached to a slender piece which reinforces the inertia of the formwork (see Figures 5 and 6 of WO 97/31165). To help this slender piece, it can be easily conferred to the connecting element in Z 1 and to the formwork walls 8 a curved form that can be memorized by attaching on the opposed side of the element 1 another longitudinal piece. Thus, the pitch determination, different on both sides of elements 1, imposes non-identical developed lengths that so develop the curved surface of the panels of the formwork.

The connecting elements 1 of a formwork panel are for example arranged in a staggering way (Figures 1 to 3). Therefore a three-dimensional connection is constituted. It is also possible to use just a connection in Z 1 so that the highest points of the waves are staggered.

CLAIMS

1. Wall made of concrete or similar materials built from an unfolded formwork/reinforcement integrated in the wall and including two formwork walls (8,8',10) placed face to face and connected by connecting elements (1) articulated to formwork walls by means of stiffeners (2) attached to the formwork walls, the interval between these unfolded formwork walls being filled with a filler (7) such as concrete, characterized in that at least one of the formwork walls includes a surcharged casing (11,12) of concrete, mortar or similar in relation to the stiffeners (2) and the articulated connecting elements (1), this casing (11,12) being arranged outside and/or inside of the formwork wall, the stiffeners (2) and the articulated connecting elements (1) and, when it is coated, the formwork wall forms in itself an inner reinforcement of the wall submerged in the wall and covered by said casing.
2. Wall according to claim 1, characterized in that at least one formwork wall (8,8') is a lattice, for example a panel made of expanded metal or a lattice made of composite materials completed by horizontal reinforcements in V.
3. Wall according to claim 1, characterized in that the stiffeners comprise stiffeners (2) attached to the formwork walls.
4. Wall according to claim 1, characterized in that the articulated connecting elements (1) of at least one formwork wall (8',10) are articulated to the stiffeners (2) with a spacing in relation to the formwork wall, these stiffeners being attached to the formwork wall by means of the spacing elements (13), in such a way that the filler (7) of the wall includes a surcharged casing (11,12) in relation to the stiffeners and to the articulated connecting elements.
5. Wall according to claim 1, characterized in that at least one wall includes a mortar casing (11) applied by a projection done before the setting of the concrete or other filler.
6. Wall according to claim 1, characterized in that said casing (11) has a thickness of at least 2.5 cm.

7. Wall according to claim 1, characterized in that it includes an insulating panel (4) inside the formwork.

8. Wall according to claim 1, characterized in that the articulated connecting elements comprise slender elements bent sensibly in zigzag (1) forming a hoop within the wall.

9. Wall according to claim 8, characterized in that it includes two staggered slender elements (1) one in relation to the other so that their staggering opposite parts are arranged facing one to the other.

10. Method for building a wall according to claim 1 by means of a formwork including two formwork walls (8,8',10) placed face to face and connected by connecting elements (1) articulated to the formwork walls by stiffeners (2) attached to the formwork walls, these connecting elements (1) allowing the walls (8,8',10) to be kept either with a gauge defining an interval intended to receive a filler (7) such as concrete, or folded for storage and transport, according to which method the formwork walls (8,8',10) are unfolded and the interval between the unfold formwork walls is filled with the filler (7), characterized in that:

- either, before the setting of the concrete or other filler, on the external face of at least one formwork wall (8), a mortar layer (11) or similar is applied, in such a way to coat the formwork wall (8),

- or a formwork is used, where at least one formwork wall (8',10) is attached but spaced from the stiffeners (2) and from the articulated connecting elements (1), and a filling material (7), such as concrete, is poured so as to coat the stiffeners (2) and the connecting elements (1) with a casing (12) adjacent to the formwork wall,

- the stiffeners (2) and the connecting elements (1) forming thus a reinforcement inside the wall so built, submerged in the wall and covered by said casing (12).

11. Method according to claim 10, characterized in that on at least one wall (8) a mortar or other casing, by projection, is applied.

12. Method according to claim 10, characterized in that a casing with a thickness of at least about 2.5 cm is applied.

13. Folding formwork intended to build a wall according to claim 1, this formwork including two formwork walls (8,8',10) placed face to face and connected by connecting elements (1) articulated to formwork walls by stiffeners (2) attached to the formwork walls (8,8',10), these connecting elements (1) allowing the walls (8,8',10) to be kept, either with a gauge defining an interval intended to receive a filler (7) such as concrete, or folded for storage and transport,

characterized in that the connecting elements (1) of at least one formwork wall (8',10) are articulated to the stiffeners (2) with a spacing in relation to the formwork wall, these stiffeners (2) being attached to the formwork wall by means of spacing elements (13), in such a way that, when the interval between the formwork walls is filled by the filler (7) such as concrete, the wall so built includes a surcharged casing (11,12) in relation to the stiffeners (2) and to the connecting elements (1).

14. Formwork according to claim 13, characterized in that the connecting elements (1) comprise slender elements bent sensibly in zigzag.

15. Formwork according to claim 14, characterized in that each bent slender element includes staggering opposite parts linked by inclined parts in a sense opposed to both parts of said opposite parts, the opposite alternated parts of all the slender connecting elements being arranged in a parallel direction one to the other and being linked to the walls.

16. Formwork according to claim 13, characterized in that the connecting elements (1) are articulated to the walls (8,8',10) by attachment means allowing only one liberty degree in rotation.

17. Formwork according to claim 13, characterized in that it includes two staggered slender elements (1) one in relation to the other, so that their opposite staggering parts are arranged facing one to the other.

18. Formwork according to claim 13, characterized in that at least one formwork wall (3) is a lattice, for example a panel made of expanded metal or a lattice made of composite materials, whose meshes are determined to evacuate the exceeding water of a filler such as concrete.

19. Formwork according to claim 13, characterized in that it includes an insulating panel (4) inside the formwork.