The AllWall Integral Masonry System with HCB/Bloc+

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The article describes a new construction technique to build three-dimensionally reinforced walls in all types of masonry materials and employing mortar instead of concrete.

The AllWall Integral Masonry System is not labour intensive and has been specifically designed for ease of construction while simultaneously controlling wall cracking and increasing the technical applications of masonry.

The Spanish Association of Concrete Block and Masonry Manufacturers, Normabloc, is promoting this construction system together with the new Bloc+ concrete block.

1. Introduction

The Integral Masonry System® (IMS) has been recently developed to allow the vertical and horizontal reinforcement of any type of masonry wall, regardless of the material employed. This new building technique provides three-dimensional wall reinforcement in all types of masonry.

The "Murfor®: reinforced masonry" technique has been regularly applied in Spain ever since its development by the author in 1992. This system employs truss-type bed joint reinforcement uniformly spaced every 60 cm or less throughout the wall. This gives the wall section a 0.03% proportion of steel by which to control cracking and employs mortar instead of concrete (Figure 1).

2. The IMS®: AllWall® Integral Masonry System®

In addition to standard "reinforced masonry", the Integral Masonry System® allows the possibility of vertically reinforcing walls with or without mortar, as the ribs employed in the same are self-bearing and do not require the mortar for the transfer of stresses (these ribs being fixed to slabs at the top and bottom by the corresponding fixing components).

The most innovative element is the AllWall® Vertical Reinforcement Rib®. This reinforcing rib consists of a double truss which may be threaded through the truss-type bed joint reinforcement.

The IMS: AllWall® Integral Masonry System® fact page (Figure 2) provides a synthesis of the System.

The IMS consists of the following steel components:

- Murfor® truss-type bed joint reinforcement
- AllWall® anchors with varying degrees of free movement
- AllWall® ribs with purpose-made fixings.

Concrete components employed in association with the IMS:

- Ferrater-Torho® piece
- HCB Hollow Concrete Block
- BlocPlus®, Bloc+®

According to the proportion of bed-joint and/or rib reinforcement employed, the system will efficiently meet the requirements of any type of wall formed with these components.

IMS® components are marketed under the AllWall trade name and the bed joint reinforcement and vertical ribs come in widths and sizes to suit all wall types and materials.

3. Building technique

Normabloc, the new Spanish association for concrete block and masonry manufacturers, wishes to promote the quality of its materials and new building techniques to aid the placement and employment of these materials.

This new focus was presented at the Construmat'03 trade fair (Barcelona) and at the Normabloc stand at the Construtec' 04 fair in Madrid (Figure 3).

A new concrete block, going under the trade name of BLOC+, has recently been developed and is particularly suited to the in-situ positioning of vertical wall reinforcement, as the block simply slides on to the previously placed reinforcement (Figures 4.a. and b).

The AllWall/BLOC+ integral masonry system incorporates the BLOC+ Hollow Concrete Block developed by Normabloc, the vertical ribs with their end attachments, Murfor type bed joint reinforcement and AllWall anchors with one or two degrees of freedom of movement for enclosed or facing walls according to the form of fixing to the support.

In order to allow the crossing of the vertical and horizontal reinforcement, the vertical ribs are threaded through the bed-joint reinforcement. This is normally performed by overlapping the bed-joint reinforcement at the point of the vertical ribs (Figures 5a, b, c and d).

The ends of the walls are normally fixed to an existing framed structure and it is common practice to place facing walls in front of the structure and to set partition walls directly against the columns. In order to obtain a certain freedom of movement when anchoring the wall to the columns, the AllWall System provides anchors with double freedom of movement for outer facing walls and one freedom of movement for enclosed partitions (Figures 6a and b).

The AllWall System also incorporates the upper and/or lower attachments of the ribs in order to ensure the transfer of stresses to the floor slabs (Figures 7.a, b and c).

The AllWall/BLOC+ System offers two possible rib positions: within or between the blocks.

When the ribs are set within the BLOC+, there is no visible interruption to the bonding of the wall and the vertical reinforcement remains totally hidden. This method is ideal for exposed concrete blockwork (Figures 8.a. and b).

When the ribs are set within the continuous vertical joints, the joint is apparent at the vertical of the reinforcement. However, in these cases the perfect interconnection with the bed-joint reinforcement allows the use of wider ribs with greater resistance against wind design loads and may readily be employed in interior or rendered walls without any unsightly effect.

The IMS makes it possible to raise walls which serve as structural panels. These panels contain uniformly distributed reinforcement formed by bed-joint trusses spaced a maximum of 40 or 60 cm (2 or 3 block courses) and vertical rib reinforcement normally spaced every 7 blocks, equivalent to 2.80 m for enclosure walls (such as the firebreak at the Madrid Barajas Airport) and every 14 blocks (equal to 5.6 m, for industrial internal partitions (Figures 10 a and b).

Once the positioning of the ribs has been decided and on arranging these in accordance with the blockwork, the ribs are then positioned below the upper slab and the blockwork is raised around the same. The blocks may be inserted around the rib to maintain the bond or, alternatively, abut the rib to leave a continuous vertical joint. In both cases the vertical reinforcement is perfectly interconnected with the bed-joint reinforcement (Figure 11 a and b).

The wall shown prior to rendering in Figure 11 b, is formed by a vertical rib set in the centre of a brick panel and threaded through bed-joint reinforcement set every 60 cm. This arrangement is far removed from a vertical movement joint set between two masonry panels.

4. Architectural applications of AllWall HCB/BLOC+

The main advantage of the AllWall BLOC+ system lies in the fact that this eliminates the need for reinforced concrete, as the ribs have their own fixing system and are self-supporting and withstand all perpendicular stresses on the same without the need for additional concrete. This then eradicates the need to employ concrete block walls filled with reinforced concrete with all the technical complications that this type of walling entails.

The diagonals of the rib trusses support the shear stress at the supports and as these are galvanized, do not rust when rendered with mortar.

It is very common to employ the AllWall BLOC+ system in very high internal or external walls in warehouses, buildings with large surface areas or special buildings.

The reinforced ribs may be employed in large one HCB thick (29 cm) walls where the lightness of the ribs, even when reinforced, allow considerable ease of handling and do not require the addition of any reinforced concrete infill (Figures 12 a and b).

On occasions it may be necessary to provide double leaf walls with narrower blocks (14 cm) and where the ribs extend across the width of both leaves, tying them together

with the bed-joint reinforcement set over both leaves and only requiring the use of mortar. This double leaf system was employed at the Madrid Community Archives at Las Rozas (Figure 13 a and b).

In walls of very great height and particularly when the upper part cannot be attached to the roof, it is possible to employ walls of different widths at the bottom and top, by combining 19 cm blockwork over the lower 6 m with 14 cm blockwork in the upper part in order to economize on materials.

In these cases, the ribs are adjusted to the thickness of the wall, using 150 mm ribs in the lower section and 100 mm ribs in the upper section. In the event that cantilever walls are required, the ribs may be set closer together in the lower section than in the upper section. This latter system was employed at the Eroski shopping Centre in Vitoria (Figure 14).

The AllWall BLOC+ system provides ideal solutions for any technical and formal situation and the system has been successfully employed for the large and curved walls at the Hotel Marques de Riscal in El Ciego (Alava), designed by the architect Frank Gehry, and directed by IDOM (Figure 15 a and b).

In this spectacular building and on account of the very high wind action requirements (200 kg/m^2), the 7 metre high 19 cm thick HCB walls required the use of double reinforced ribs with shear reinforcement. This system was also employed in the curved walls of lower height but similar wind pressure and where it was necessary to place the ribs every 1.4 m (Figures 16 a and b).

The Ghery building employs stone cladding and wavy steel forms set on and around concrete block walls built with the AllWall Integral Masonry System (figure 17).

AllWall Ribs have recently been further improved through manufacture in increased section diameters. This improvement makes the system even more economical by improving the performance of the steel components.

Partition and enclosure walls are currently being built at Spanish airports using concrete blocks and the new ribs.

At Malaga Airport, the partition walls are formed in 9 metre square panels formed in HCB and set between columns and slabs. The panels incorporate Murfor RND. 4/Z-150 mm reinforcement every 60 cm in height and two AllWall AW-RIB. 10/Z-140 mm ribs set in the centre of each panel.

At the Alicante Airport, a facing wall is being built using double Hollow Concrete Block 15 (30 cm width) in 11.20 m high by 40 m long clear wall panels. These walls incorporate Murfor RND. 4/Z-150 mm bed-joint reinforcement every 40 cm, two AW-RIB 5/Z-200 mm AllWall Ribs, with two 12 mm diameter (stainless steel) reinforcements, set every 1.60 m. The rib fixings are embedded and height adjustable and are specially designed to withstand wind action on an exposed 11 m high wall,

Many buildings have already been built in Spain using this system on account of the many advantages offered by the same. Back-up support is provided by the AIA Arquitectura Technical Department to ensure the suitable employment of the patented AllWall system and one that is now beginning to be exported to other countries in the European Community.

Bibliography

Sobre la denominación de: "la fábrica armada". Adell, J.M.
Actas II Congreso Hispanoamericano de Terminología de Edificación. Valladolid 1987.

Arquitectura de investigación con fábrica armada ("Architecture and research with reinforced masonry"). Adell, J.M.
Revista Informes de la Construcción. Vol. 44. nº 421. Instituto Eduardo **Torroja**. Consejo Superior de Investigaciones Científicas. Madrid, Septiembre/octubre, 1992.

Razón y ser de la fábrica armada (Reason & being of the reinforced masonry) Adell, J.M.
Revista Informes de la Construcción. Vol. 44. nº 421. Instituto Eduardo **Torroja**. Consejo Superior de Investigaciones Científicas. Madrid, Septiembre/octubre, 1992.

Manual Murfor: La Fábrica Armada. Adell, J.M; Lahuerta, J.A. (Cálculo).
Bekaert Ibérica, S.A. Barcelona, 1992 (reeditado en 2002).

La fábrica armada. Adell, J.M.
Ed. Munilla-Lería. Madrid 2000. ISBN 84-89150-39-7.

The integral masonry system and the contemporary façade. Adell, J.M.
Paper of the12th International Brick/Block Masonry Conference. Madrid 2000.

The universal masonry unit and rib reinforcement. Adell, J.M.
Paper of the12th International Brick/Block Masonry Conference. Madrid 2000.

Manuales AllWall: Sistema de Albañilería Integral: ("Allwall: Integral Masonry System")
Adell, J.M. Ed. AWS, AllWall Systems. Madrid entre los años 2001-2005.
- Bloque de hormigón hueco para todos los fabricantes de BHH (2002)
- Pieza Ferrater para Torho (2003)
- Brick Vallés para Calibloc (2003)
- Bloc+ (BlocPlus) para Normabloc (2005)

Código de Buena Práctica para la ejecución de Fábricas con Bloques y Mampostería de Hormigón. Roces, C. Ed. Normabloc. Madrid, 2004.

Normabloc y BLOC+ en Construtec. Adell, J.M.
Revista Editeco nº 210. Diciembre 2004 (páginas 54 y 55).

The Integral Masonry System. Adell, J.M. y Dávila, Mª D.
13th IBMAC. Amsterdam, Junio 2004 (páginas 519-528).

Manual NORMABLOC: Asociación Nacional de Fabricantes de Bloques y Mampostería de hormigón. Adell, J.M. Ed. Normabloc. Madrid, 2005 (en edición).