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Description

The present patent application relates to a new kind of self-supporting lattice to be used in the realization of buildings by adopting mixed steel-concrete reticular systems. They are generally structures made up of pre-fabricated metal reticular beams which are assembled in a concrete casting realized in the building yard. The placement of such structures comprises first the positioning of the pre-fabricated reticular beam and in the following the realization of the concrete casting. Therefore, two phases of the useful life of such structures, commonly called phase 1 and phase 2, can be distinguished.

The phase 1 is the phase in which the resistance is provided totally by the steel lattice, which being self-supporting, has to resist to the floor and completing fluid concrete weight, to the weight of the additional reinforcement prearranged before the casting at the points stressed by negative moments and to accidental loads possible during the phase 1. The steel lattice, being subjected to each above described action, has to remain in an acceptable deformation field, which is expected and calculated in the project phase. In phase 2, instead, the resistance is provided by the structure formed by the steel lattice and by the concrete of the additional casting, which at the end of the curing, has developed the mechanical properties expected in the project phase. Since the additional casting of concrete is made on the entire deck, it is able to make the entire structure integral, thus providing a continuous beam assembly.

During phase 1, according to constructive systems known at the state of the art and commonly used in the building field, the prefabricated steel lattices coming from the workshops are rested, by means of suitable cranes, on the heads of pillars, thus realizing structures, statically schematizable as beams simply rested on the ends. During phase 2, consequently to the concrete curing, the reference static model for calculating stresses and deformations becomes that of a fixed beam, the resistant structure is made up of the pre-stressed steel lattice and the concrete, with acting loads typical of the working phase.

A reticular beam known at the state of the art, which is rested between two pillars is shown in figure 1. WO 02/101168 A1 discloses a metal structure according to the present invention. Figures 1 and 2 show a lattice according to an embodiment known at the state of the art.

The embodiments of the metal lattices known at the state of the art are limited since they impose an over-dimensioning of the metal reinforcements with respect to the loads which they have to support actually in phase 2. In fact in the phase 1, in which the structural model is that of a beam, which is simply rested on the ends, the sole steel lattice has to resist to all the loads acting thereon, and so to its own weight, to the floor and concrete casting weight and to the accidental loads. This feature is called "metal lattice self-supporting during the phase 1".

In such constraint and load conditions, which generally can be assimilated to an uniformly distributed load, a possible crisis of the lattice arrives owing to the instability of the compressed rods in the points of the beam where the cutting has higher values.

Since the core reinforcements, for construction easiness, are provided with the same diameter along the entire development of the beam, it is assumed that the reinforcement diameter of the entire reticular lattice is dimensioned on the basis of the maximum acting stress, thus resulting in a substantial over-dimensioning in the less stressed areas. In working conditions, in fact, the acting load is uniformly distributed, and the core reinforcements in the middle of the lattice have the same diameter of those in the end sections, even if they are subjected to very low stresses. It is therefore clear that they are over-dimensioned. Moreover, in phase 2, to the cutting resistance capacity of the sole reinforcement is summed the contribution of the concrete which gives a significant contribution in the whole resistant mechanism.

The aim of the present invention is therefore to provide a self-supporting steel lattice able to overcome the limits linked to the embodiments known at the state of the art and to allow a low over-dimensioning of the reinforcements of the same lattice at equal acting load conditions. The basic idea of the present invention is in fact that a different topologic arrangement of the lattice allows to exploit at best the features of the different materials, which have to resist to in the different phases of the useful life of the structure, thus avoiding the over-dimensioning of the steel structures in the less stressed areas. These and other advantages will be highlighted in the description of the invention, which refers to the appended drawings.

Figures 1 and 2 show a lattice according to an embodiment known at the state of the art. Figures 3 and 4 show a preferred embodiment of the metal lattice according to the present invention. Figure 5, finally, shows a second embodiment of the metal lattice according to the present invention.

As is shown in figures 1 and 2, the metal lattices known at the state of the art are realized by joining a plate in the lower portion (11) and a series of upper longitudinal reinforcements (12), joined by a series of couples of angular shaped reinforcing rods (13, 14) so arranged to form a shape similar to a rectangular based pyramid, with the base resting on the lower plate (11) and the vertex at the upper longitudinal reinforcements (12), to which the angles of the reinforcing rods (13, 14) are welded. Along the whole length of the lattice (1), a series of pyramids is set side by side, whose inclined edges are formed by couples of angular shaped reinforcing rods (13, 14).

As is shown in figure 3, the self-supporting metal lattice object of the present invention has a modular structure similar to the one of the lattice known at the state of the art: there are provided a lower flat element...
According to the invention there is provided a couple of reinforcing rods (25, 26, 27, 28) at each one of the two ends of the lattice (2). Each reinforcing rod (25, 26, 27, 28) can be connected with an end at the terminal portions (211) of the lower reinforcing element (21) and with the other end connected to the longitudinal reinforcement (22) and to the reinforcing rods (23, 24) at the second or third couple of reinforcing rods starting from the end. In practice, the additional reinforcements (25, 26) are connected at the vertex of the second or third pyramid formed by the reinforcing rods.

Alternatively, the reinforcements can be connected to the terminal elements (40) indicated in figure 4, preferably "L" shaped, used to rest the beam on the pillar, or at the base of one between the first two pyramids formed by the reinforcing rods starting form the end.

Another feature of the preferred embodiment of the lattice according to the present invention, well visible in figure 5, is that it comprises another additional reinforcement (29), arranged in transversal direction to the axis of the lattice (2) at the crossing between the reinforcing rods of the lattice (23, 24) and the additional reinforcements of the lattice (25, 26). This additional reinforcement functions as stiffening element since it provides a constraint to the additional reinforcements (25, 26), thus reducing the inflection free length and so increasing the compression critical load value.

A series of experimental tests, carried out both on the metal lattices known at the state of the art and on metal lattices object of the present invention has shown that the lattices according to the present invention realized with cutting reinforcements \( \varphi \) 12 and provided with additional reinforcements according to what described at the constraints have performances in phase 1, which in terms of resistance and deformability, can be compared to those of the metal lattices known at the state of the art, realized with reinforcements \( \varphi \) 14 constant along the entire beam development. What described is only a preferred embodiment of the self-supporting lattice according to the present invention as defined by the following claims.

**Claims**

1. Metal structure for mixed steel-concrete reticular systems comprising:
   - upper longitudinal reinforcements (22) and lower steel or concrete longitudinal resistant elements (21) connected by means of reinforcements (23, 24) to form a beam (2), said reinforcements (23, 24) being arranged in a modular manner along the whole length of said beam (2) and comprising angular shaped rods connected to said upper longitudinal reinforcements (22) and to said lower resistant elements (21) so that they form the inclined edges of a series of rectangular based pyramids, with the base arranged on said lower longitudinal reinforcements (21) and the vertex arranged on said upper longitudinal reinforcements (22), each pyramid forming a module, said beam (2) further comprising additional reinforcements (25, 26) with respect to the modular arrangement of the reinforcements of the beam (2) arranged at the ends of the beam (2), said additional reinforcements comprising a couple of rods (25, 26, 27, 28) for each end of the beam connected to said lower steel or concrete longitudinal resistant elements (21) and to said upper longitudinal reinforcements (22) characterized in that the connection of the first ends of said rods (25, 26, 27, 28) to the lower resistant elements (21) occurs
     - at the terminal portion of said lower resistant elements (21)
     - or at a terminal resting element (40) situated at the end of said beam
     - or at the base of one of the first pyramids said base being formed by the reinforcing rods starting from the end of the beam and the connection of the second ends of said rods (25, 26, 27, 28) to the upper longitudinal reinforcements (22) occurs at the connection of the upper longitudinal reinforcements (21) of a module other than the first one starting from the end of the beam (2) of said reinforcements (23, 24) arranged in modular manner.

2. Metal structure for mixed steel-concrete reticular systems according to claim 1, characterized in that the connection of said rods (25, 26, 27, 28) to the upper longitudinal reinforcements (22) occurs at the connection of the upper longitudinal reinforcements (21) of the second module of said reinforcements (23, 24).

3. Metal structure for mixed steel-concrete reticular systems according to any one of the preceding claims, further comprising an additional reinforcing rod (29), arranged orthogonally to the axis of the beam (2), which connects said reinforcing rods (25, 26, 27, 28) to the first module of said reinforcements (23, 24).

4. Metal structure for mixed steel-concrete reticular
systems according to any one of the preceding claims, characterized in that the structure is realized in carpentry steel or in concrete steel and all the connections between the reinforcements are realized by welding.

5. Mixed steel-concrete reticular systems comprising a metal structure according to any one of the preceding claims.

**Patentansprüche**

1. Metallstruktur für gemischte Stahlbeton-Netzsysteme, bestehend aus:

   - Obere längere Verstärkungen (22) und untere Stahl- oder Betonbeständige Längselemente (22) durch Verstärkungen (23, 24) um einen Balken (2) zu bilden, wobei die besagten Verstärkungen (23, 24) auf modulare Weise auf der gesamten Länge des betreffenden verbundenen Balkens (2) angeordnet werden, und die winkelförmig geformte Ruten zu den betreffenden oberen Längsverstärkungen (22) und zu den betreffenden niedrigeren beständigen Elementen (21) umfassen, so dass sie die Winkel einer Reihe von auf Rechtecken basierenden Pyramiden bilden, wobei die Basis auf den betreffenden unteren Längsverstärkungen (22) und jede Pyramide ein Modul bildet, angeordnet sind und der Gipfel auf den betreffenden oberen Längsverstärkungen (22) angeordnet ist, wobei der besagte Balken (2) darüber hinaus zusätzliche Verstärkungen (25, 26) im Hinblick auf die modulare Anordnung der Verstärkungen des Balken (2) umfasst, die an den Enden des Balkens (2) angeordnet sind, wobei zusätzliche Verstärkungen, die eine Reihe von Ruten (25, 26, 27, 28) für jedes Ende des Balkens an den betreffenden unteren Stahl- oder betonbeständigen Elementen (21) und den besagten oberen Längsverstärkungen (22) enthalten, die sich dadurch auszeichnen, dass die Verbindung der besagten Ruten (25, 26, 27, 28) an den ersten Enden der unteren Widerstandselemente (21) auftreten.

   - Am Endabschnitt der betreffenden unteren Widerstandselemente (21).

   - Oder am Ende des Ruheelements (40), das sich am Ende des betreffenden Balkens befindet.

   - Oder an der Basis einer der ersten Pyramiden besagter Basis, die durch die Verstärkungsruten gebildet werden, die am Ende des Balkens beginnen. Und die Verbindung der zweiten Enden der betreffenden Ruten (25, 26, 27, 28) zu den oberen Längsverstärkungen (22) treten an den Verbindungen der oberen Längsverstärkungen (21) eines anderen Moduls als des Moduls auf, das am Ende des Balkens (2) der betreffenden Verstärkungen (23, 24) auftritt, die modular angeordnet sind.

2. Metallstruktur für gemischte Stahlbeton-Netzsysteme gemäß Anforderung 1, darin ausgedrückt, dass die Verbindung der betreffenden Ruten (25, 26, 27, 28) an den oberen Längsverstärkungen (22) an den Verbindungen der oberen Längsverformungsbehinderungen (21) des zweiten Moduls der betreffenden Verstärkungen (23, 24) auftreten.

3. Metallstruktur für gemischte Stahlbeton-Netzsysteme gemäß den vorherigen Anforderungen, die darüber hinaus eine zusätzliche Verstärkungsrute (29) umfassen, die rechtwinklig an der Achse des Balkens (2) angeordnet sind, der die Verstärkungsruten (25, 26, 27, 28) mit dem ersten Modul der betreffenden Verstärkungen (23, 24) verbinden.


5. Gemischte Stahlbeton-Netzsysteme, die eine Metallstruktur gemäß den vorherigen Anforderungen umfassen.

**Revendications**

1. Structure métallique pour systèmes réticulaires mixtes acier-béton comprenant :

   - des renforts longitudinaux supérieurs (22) et des éléments résistants longitudinaux inférieurs en acier ou béton (21) reliés au moyen de renforts (23, 24) pour former un faisceau (2), lesdits renforts (23, 24) étant agencés de façon modulaire sur toute la longueur dudit faisceau (2) et comprenant des tiges de forme angulaire reliées auxdits renforts longitudinaux supérieurs (22) et auxdits éléments résistants inférieurs (21) de manière à former les arêtes inclinées d’une série de pyramides à base rectangulaire, avec la base disposée sur lesdits renforts longitudinaux inférieurs (22) et le sommet disposé sur lesdits renforts longitudinaux supérieurs (22), chaque pyramide formant un module, ledit faisceau (2) comprenant également des renforts supplémentaires (25, 26) relativement à l’agencement modulaire des renforts du faisceau (2) disposés.
aux extrémités du faisceau (2), lesdits renforts supplémentaires comprenant un couple de tiges (25, 26, 27, 28) pour chaque extrémité du faisceau reliées auxdits éléments résistants longitudinaux inférieurs en acier ou béton (21) et auxdits renforts longitudinaux supérieurs (22), caractérisée en ce que la liaison des premières extrémités desdites tiges (25, 26, 27, 28) aux éléments longitudinaux inférieurs (21) intervient
- au niveau de la partie terminale desdits éléments résistants inférieurs (21)
- ou au niveau d’un élément d’appui terminal (40) situé à l’extrémité dudit faisceau
- ou à la base de l’une des premières pyramides, ladite base étant formée par les tiges de renfort partant de l’extrémité du faisceau et la liaison des secondes extrémités desdites tiges (25, 26, 27, 28) aux renforts longitudinaux supérieurs (22) intervient au niveau de la liaison des renforts longitudinaux supérieurs (21) d’un module autre que le premier partant de l’extrémité du faisceau (2) desdits renforts (23, 24) agencés de façon modulaire.

2. Structure métallique pour systèmes réticulaires mixtes acier-béton selon la revendication 1, caractérisée en ce que la liaison desdites tiges (25, 26, 27, 28) aux renforts longitudinaux supérieurs (22) intervient au niveau de la liaison des renforts longitudinaux supérieurs (21) du deuxième module desdits renforts (23, 24).

3. Structure métallique pour systèmes réticulaires mixtes acier-béton selon l’une quelconque des revendications précédentes, comprenant en outre une tige de renfort supplémentaire (29), disposée perpendiculairement à l’axe du faisceau (2), qui relie lesdites tiges de renfort (25, 26, 27, 28) au premier module desdits renforts (23, 24).

4. Structure métallique pour systèmes réticulaires mixtes acier-béton selon l’une quelconque des revendications précédentes, caractérisée en ce que la structure est réalisée en acier de charpente ou en acier à béton et toutes les liaisons entre les renforts sont réalisées par soudage.

5. Systèmes réticulaires mixtes acier-béton comprenant une structure métallique selon l’une quelconque des revendications précédentes.
REFERENCES CITED IN THE DESCRIPTION

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