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(54) **PRODUCING OF A STEEL BEAM AND A STEEL BEAM**

(57) Method for manufacturing a steel beam (1), in which method base plate (2), web parts (3) and top plate (4) of a steel beam (1) are welded as a beam so that a space (5) for concrete is formed between them. In the method supports (7) are fixed to the base plate (2) at regular intervals in the longitudinal direction of beam (1), to which supports (7) fire steels (8) extending in the longitudinal direction of the beam (1) are fixed, the web parts (3) are installed to the base plate (2) against the supports

(7) so that the supports (7) are between the web parts (3), and tightening bars (16) are arranged through opposite air venting holes (10) of the web parts (3). Thereafter, the top plate (4) is placed on the tightening bars (16) between the web parts (3), the web parts (3) are tightened against edges of the top plate (4), the web parts (3) are supported in place against the supports (7) and the top plate (4) for welding, and the tightening bars (16) are removed from the air venting holes (10) before welding.

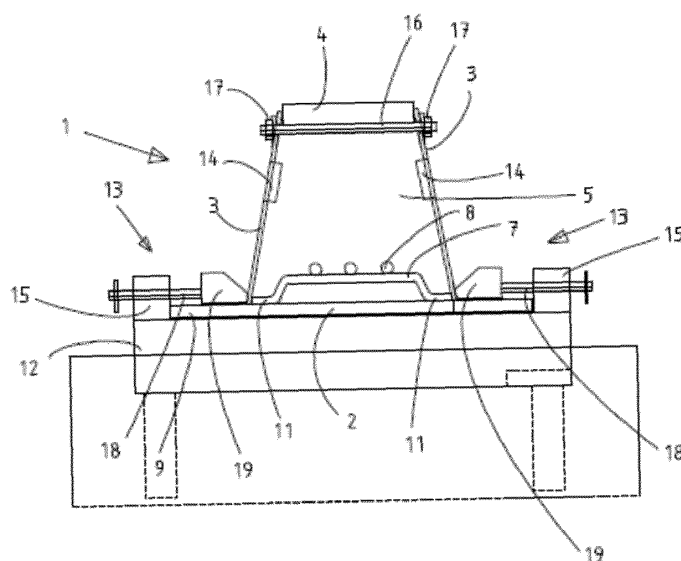


Fig. 1

Description

[0001] The object of the invention is a method for producing of a steel beam according to claim 1. Furthermore, the object of the invention is a steel beam.

[0002] The invention relates to a steel beam, on which hollow-core slabs, composite slabs, thin shell slabs and other load-bearing structures of a building can be supported. During concreting, a beam is filled with concrete, and after the concrete has hardened, the beam serves as a composite structure. With a composite structure longer beam spans can be achieved, and with regular beam spans the amount of steel can be reduced.

[0003] FI 118816 describes a method and means for manufacturing a steel beam. In the method, the base plate, web parts and top plate are cut from a plate material, the afore mentioned parts are assembled so that a space is formed between them for concrete to be fed through the openings in the web part, and the parts are welded to one unity. Web plates are cut to a curved shape according to precambering, and side supports determining the position of web plates and centre supports determining the location of the top plate are fastened to the base plate at regular intervals in the longitudinal direction of the beam. Furthermore, a force is directed to the base plate that forces the base plate to the curvature determined by web plates, wherein side plates determine the position of web plates, and centre supports determine the curvature of top plate to be set in place.

[0004] Side supports and centre supports, which are used to assemble a beam cause a problem during concreting the inside of the beam, as it has to be ensured that the beam is filled with concrete. Side supports and centre supports form a barrier for concrete to flow in longitudinal direction inside the beam, wherein air pockets may be formed into the beam. This constitutes a structural risk. If, for example, there will be air pockets left behind supports in top side of the beam, bending strength of the beam decreases in that area, wherein the weight-carrying capacity of the beam decreases. It is difficult to prevent the forming of air pockets, and the existence of air pockets can not be controlled either. Air pockets that are left in concrete are particularly harmful in two areas of a beam. In the upper edge of a beam an air pocket under top plate decreases the load-carrying capacity of the beam. In the lower edge of a beam an air pocket under fire steels, in turn, decreases essentially the load-carrying capacity of a beam in case of a fire, as there has to be concrete, which protects fire steels, all over between base plate of a beam and fire steels. If even a one area of centre supports and side supports lacks concrete, the load-carrying capacity of a beam in case of a fire can be lost completely.

[0005] The aim of this invention is to achieve an improved method for manufacturing a steel beam by means of which the above mentioned problems can be reduced.

[0006] The aim of the invention is achieved with a method according to claim 1. In the method according to the

invention supports are fixed to the base plate of a steel beam at regular intervals in the longitudinal direction of the beam, to which supports fire steels extending in the longitudinal direction of the beam are fixed, the web parts of the beam are fixed to the base plate against supports so that supports are between web parts, tightening bars are arranged through opposite air venting holes of web parts, top plate of the beam is placed on tightening bars between the web parts, and the web parts are tightened against edges of the top plate. Thereafter, web parts are supported in place against supports and the top plate for welding, and tightening bars are removed from air venting holes before welding. Thereafter, the base plate, the web plates and the top plate are welded together to obtain a beam so that a space for concrete is formed between them.

[0007] Significant advantages are achieved by the invention. In the solution of the invention the desired shape of the top plate of a beam is obtained, and web parts are tightened against top plate by tightening bars which are placed to air venting holes of opposite web parts. After assembling of top plate tightening bars are removed, wherein no supports or other structures that support top plate remain inside the beam, which could cause air pockets while the beam is filled with concrete. In the solution according to the invention no structure remains directly under top plate, which structure would prevent the free flowing of concrete inside the beam, and the beam can be totally filled with concrete.

[0008] According to one embodiment of the invention end parts of supports are fixed to the base plate next to web parts, and parts of supports between end parts are at a distance from the base plate. Then the concrete fed inside the beam can freely flow between the base plate and supports along the base plate. Due to this, the space below the fire steels can be filled as fully as possible with concrete, which increases the load-carrying capacity of the beam in case of a fire.

[0009] For concreting of a beam, feeding openings for concrete are required for the web parts of the beam through which feeding openings concrete can be cast inside the beam. These feeding openings are formed in prior art so that their shape is circular and edges of the opening are bent inwards to form a conical structure. This shape is required due to strength technical properties of a beam. This shape, however, creates a problematic area for concreting of a beam, as the area will remain inside the beam above cone, to which area concrete will not flow, as the area locates right above the feeding opening and the cone shape forms a shadow area. To eliminate this problem, in one embodiment of the invention a feeding opening for concrete is shaped as a rectangle or a quadrat, and only the vertical edges of the feeding opening are bent inwards to create the required strength technical properties. Top edge, e.g. horizontal edge, is not bent, wherein concrete can freely flow upwards and adverse air pockets are not formed. Also the lower edge of the feeding opening is not bent, wherein concrete can

freely flow also downwards.

[0010] In the following, the invention will be described by the aid of embodiments with reference to the attached drawings, wherein

Fig. 1 shows an end view of a steel beam manufactured by a method according to one embodiment of the invention, and

Fig. 2 shows a side view of a steel beam of Fig. 1.

[0011] Slab systems of a building, such as hollow-core slabs, composite slabs and shell slabs and in-situ cast concrete slabs can be supported on a steel beam presented in the drawings. During seam concreting or other concreting, the beam 1 is filled with concrete, and after the concrete has hardened, the beam 1 serves with concrete as a load-carrying composite structure for slab systems.

[0012] A steel beam 1 comprises a base plate 2, to which supports 7 for longitudinal fire steels 8 are fixed at regular intervals in the longitudinal direction of beam 1. Supports 7 are fixed to a top surface of the base plate 2 by welding, for example. Fire steels 8 are fixed to top surfaces of the supports 7 with steel bands, for example. There are at least two fire steels 8, but in different embodiments there can also be more of them. Also two adjacent web parts 3 have been fixed to the base plate 2 at a distance from each other, which web parts 3 form the sides of beam 1. Base plate 2 extends in lateral direction of beam 1 into sides of the web parts 3 and thus forms protruding parts 9 for slab systems to be supported on beam. Web parts 3 are plate-shaped. Supports 7 are between web parts 3. Web parts 3 have been installed against ends of supports 7, wherein the supports 7 determine the location of lower edges of web parts 3 in lateral direction of beam 1. The ends of the supports 7 are shaped to the angle corresponding to inclination of the web parts 3, i.e. to the same angle as the angle between the web parts 3 and base plate 2. The angle between the web parts 3 and the base plate 2 can be less than 90°, wherein the distance between the web parts 3 is smaller in upper parts of the web parts than in lower parts. Alternatively, another web part 3 can be perpendicularly against base plate 2, wherein beam 1 is so-called edge beam.

[0013] Web parts 3 are connected to each other with their upper edges by top plate 4. Top plate 4 is between the web parts 3. Base plate 2, the web parts 3 and the top plate 4 form a space 5, which can be filled with concrete. Web parts 3 are fixed to the base plate 2 and to the top plate 4 by welding, for example. The ends of the steel beam 1 can be closed by end plates (not shown). There are concrete feeding openings 6 in the web parts 3 through which feeding openings 6 concrete can be fed into the space 5 formed by the base plate 2, the web parts 3 and the top plate 4. Openings 6 can be square-shaped or rectangular-shaped, for example, or circular-

shaped. If the openings 6 are rectangular-shaped or square-shaped, only vertical edges of openings 6 are bent towards interior of beam 1, wherein there are projections 14 on edges of openings 6 extending into space 5. Projections 14 serve as bonds for concrete in the space 5. Horizontal edges of openings 6 are unbent, wherein concrete can freely move upwards at opening 6 and also move downwards, which reduces the forming of air pockets above and underneath an opening 6. Furthermore, there are air venting holes 10 in the web parts 3 for discharging air from the space 5. Air venting holes 10 are circular-shaped. Top edges of air venting holes 10 are at least at the same height as the lower surface of the top plate 4. There are air venting holes 10 at least at both ends of beam 1 or near the ends, and one in the middle of the beam, wherein air venting can be secured.

[0014] Supports 7 are formed so that their end parts 11 next to the web parts 3 are against the base plate 2 and fixed to the base plate 2. The part of the support 7 between end parts 11 is at a distance from the base plate 2. Then the concrete fed into space 5 can flow between the base plate 2 and the supports 7 along the base plate 2. Due to this, space 5 can be filled as fully as possible with concrete, which reduces the amount of air pockets forming in space 5. Fire steels 8 are fitted to supports 7 between end parts 11, i.e. to the part of support 7, which is separate and at a distance from base plate 2. Supports 7 can be manufactured from steel plate or steel bar, for instance.

[0015] Steel beam 1 is manufactured as follows. Base plate 2, web parts 3 and top plate 4 are cut from plate material into desired shape by conventional methods, for example by flame cutting. Web parts 3 are provided with feeding openings 6 for concrete to be fed into beam, and with venting holes 10 for air to be discharged from beam. Vertical edges in feeding openings 6 for concrete are bent towards inner part of beam to form projections 14 extending into space 5. Horizontal edges 6 in openings 6 are left unbent. Web parts 3 are cut to a curved shape according to pre-cambering so that the centre part of web parts 3 extend higher than the ends. Bending of beam 1, which is caused by loading directed into beam 1, is compensated by pre-cambering.

[0016] Base plate 2 is set on a platform 12. Platform 12 can be curved, or platform can be provided with support elements, against which bottom plate 2 is pressed and thus bent to a curved shape according to web parts 3. Thereafter, supports 7 of fire steels 8 are fixed to base plate 2 at a desired distance from each other in the longitudinal direction of beam 1. Fire steels 8 are fixed to supports 7 by steel bands, for example.

[0017] In the next step, web parts 3 are set against ends of supports 7 and supported in place. Web parts 3 can be supported with support arrangements 13 of figure 1, which comprise support parts 19 fixed to thread bars 18, which support parts 19 are arranged against web part 3 so that web part 3 is between support part 19 and end of support 7. Brackets 15 are fixed to platform, which

brackets 15 comprise threaded holes, through which thread bars 18 are threaded. By threading thread bars 18 support parts 19 press web parts 3 against supports 7. [0018] Tightening bars 16, for example threaded bars, having a diameter slightly smaller than that of air venting holes 10, are arranged through opposite air venting holes 10 of web parts 3. Tightening bars 16 are presented in figure 1. Thereafter, top plate 4 is placed on tightening bars 16 between web parts 3. Height location and diameter of air venting holes 10 as well as diameters of tightening bars 16 are such that top plate 4 is at a desired height between web parts 3. As web parts 3 are curved according to pre-cambering, air venting holes 10 and tightening bars 16 arranged through them form a corresponding curved shape. Top plate 4 is bent against tightening bars 16 to a curved shape according to pre-cambering. There are several tightening bars 16, wherein top plate 4 will be formed as is desired. Nuts 17 are fastened to ends of tightening bars 16, which nuts 17 are tightened against web parts 3, wherein web parts 3 are pressed against edges of top plate 4. Top plate 4 and web parts 3 are supported in place, after which nuts 17 are loosened and tightening bars 16 are removed from air venting holes 10. Thereafter, base plate 2, web parts 3 and top plate 4 are welded to a beam so that a space 5 for concrete is formed between them. Web parts 3 are welded to bottom plate 2 and to top plate 4. End plates are fixed to ends of beam 1 by welding. Before fixing to beam 1, fire steels, for example two fire steels extending in the longitudinal direction of beam 1 can be fixed by welding, for instance, to end plates, which fire steels are arranged so that they overlap the fire steels 8 on supports 7.

[0019] At the assembling place beam 1 is fixed in place and slab systems are assembled on protruding parts 9, after which beam 1 is filled with concrete.

[0020] It is obvious to the person skilled in the art that the different embodiments of the invention are not limited solely to the examples described above, and that they may therefore be varied within the scope of the claims presented below.

Claims

1. Method for manufacturing a steel beam (1), in which method a base plate (2), web parts (3) and a top plate (4) of the steel beam (1) are welded to a beam so that a space (5) for concrete is formed between them, **characterized in that**

- supports (7) are fixed to the base plate (2) at regular intervals in the longitudinal direction of the beam (1), to which supports (7) fire steels (8) extending in the longitudinal direction of the beam (1) are fixed,
- the web parts (3) are installed to the base plate (2) against the supports (7) so that the supports (7) are between the web parts (3),

- tightening bars (16) are arranged through opposite air venting holes (10) of the web parts (3),
- the top plate (4) is placed on the tightening bars (16) between the web parts (3),
- the web parts (3) are tightened against edges of the top plate (4),
- the web parts (3) are supported in place against the supports (7) and the top plate (4) for welding, and
- the tightening bars (16) are removed from the air venting holes (10) before welding.

2. Method according to claim 1, **characterized in that** the web parts (3) are provided with concrete feeding openings (6) for feeding concrete into the space (5), which concrete feeding openings (6) are rectangle-shaped or quadrad-shaped, and with air venting holes (10) for discharging air from space (5), which air venting holes are circular-shaped.
3. Method according to claim 1 or 2, **characterized in that** web parts (3) are provided with concrete feeding openings (6), and only vertical edges of the openings (6) are bent towards inside of the beam (1) to form projections (14) extending to the space (5).
4. Method according to any of the preceding claims, **characterized in that** the areas of supports (7) that are to be arranged against the web parts (3) are formed so that they correspond to the form of the inclination of the web parts (3).
5. Method according to any of the preceding claims, **characterized in that** transverse end parts (11) of the supports (7) are fixed to base plate (2), and parts of the supports (7) between the end parts (11) are at a distance from the base plate (2), and the fire steels (8) are fixed to the supports (7) between the end parts (11).
6. Method according to any of the preceding claims, **characterized in that** nuts (17) are fixed to the tightening bars (16), and by fastening of the nuts (17) the web parts (3) are tightened against the edges of the top plate (4).
7. Method according to any of the preceding claims, **characterized in that** the web parts (3) are curved-shaped, and bottom plate (2) is bent to curved-shape in accordance with web parts (3) before assembling of the web parts (3).
8. Method according to claim 7, **characterized in that** the top plate (4) is bent on the tightening bars (16) to curved-shape in accordance with the web parts (3)
9. A steel beam (1) comprising a base plate (2), web parts (3) and a top plate (4), which have been welded

as a beam so that there is a space (5) between them for concrete, **characterized in that** supports (7) are fixed to the base plate (2) at regular intervals in a longitudinal direction of the beam (1), to which supports (7) fire steels (8) extending in the longitudinal direction of the beam (1) are fastened, which supports (7) are between web parts (3). 5

10. Steel beam (1) according to claim 9, **characterized in that** transverse end parts (11) of the supports (7) are fastened to the base plate (2), and parts of the supports (7) between the end parts (11) are at a distance from the base plate (2), and fire steels (8) are fastened to the supports (7) between the end parts (11). 10 15

11. Steel beam (1) according to claim 9 or 10, **characterized in that** there are feeding openings (6) for concrete in the web parts (3), and only vertical edges of the openings (6) are bent towards inside of the beam (1), wherein edges form projections (14) extending into the space (5). 20

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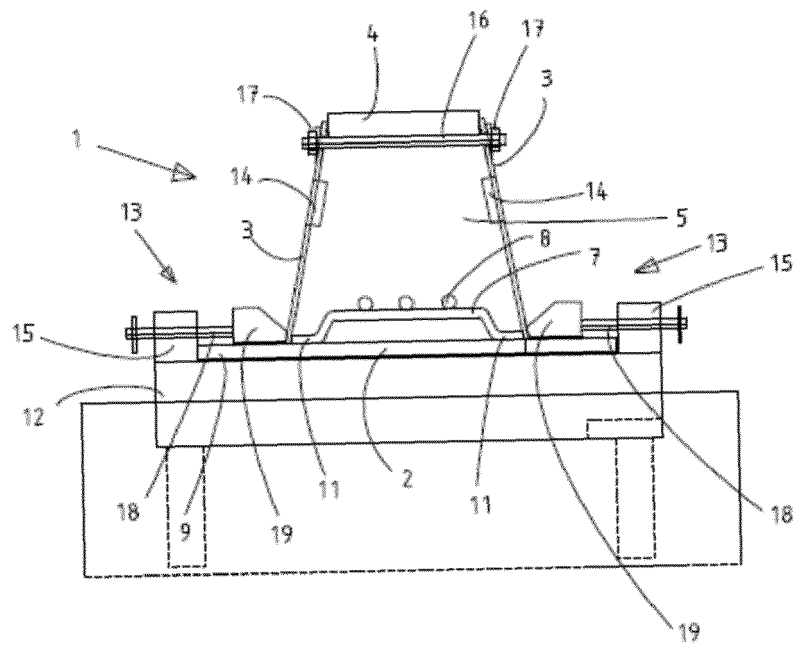


Fig. 1

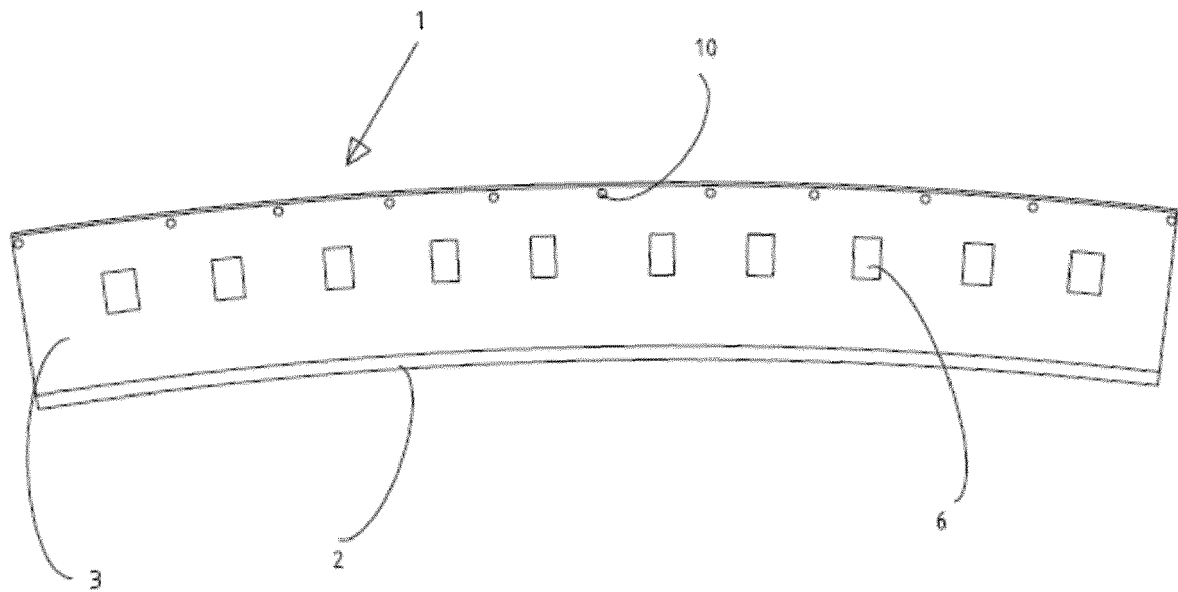


Fig. 2



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Application Number
EP 16 19 6503

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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 26 January 2017	Examiner Petrinja, Etjel
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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