

METAL FIBER HAVING A CHAMFER IN THE FIBER EDGE EXTENDING IN THE
LONGITUDINAL DIRECTION OF THE FIBER

The invention concerns a metal fibre having fibre outer surfaces which are oriented substantially at a right angle to each other, also with angled ends in the form of a clip, for stabilising, consolidating or fastening materials such as concrete, wood and the like.

Metal fibres of that kind in a straight configuration are used as a concrete additional means for example for improving the performance of concrete in respect of capability for carrying tensile, compression and shock loads, whereby it is also possible for example to prevent an incipient crack formed in the concrete from extending further due to increasing expansion thereof. Metal fibres with angled ends, that is to say of a U-shape configuration in the form of clips, are used as a connecting element in relation to soft and elastic materials, that is to say for example in the broadest sense in the wood sector, in the building and furniture industry and in the plastic sector.

In regard to all those uses it is generally desirable for the metal fibres to be so influenced in respect of their shape that they are capable of carrying tensile forces in relation to the materials surrounding them. In the case of metal fibres for use in concrete, which are usually in the form of wire steel fibres, it is usual for that purpose to provide for example cranked portions at the fibre ends, in which case it can be observed that the tensile forces which can be carried thereby are relatively limited as the wire steel fibre changes its hook shape under a tensile loading and can therefore be pulled out through the passage formed by it. In principle only the frictional engagement between fibre and concrete is improved by the hook shape at both ends of the wire steel fibre.

In the case of staple clips which are processed for example by means of electric tackers and which for that purpose are glued in pluralities thereof in the form of bars, such a configuration is scarcely possible so that here it is always necessary to operate with clips with a comparatively large leg length in order to apply sufficient frictional forces by the material surrounding the clip, which prevent the clip from being easily pulled out.

On the basis thereof the object of the invention is to improve metal fibres of both types of the kind set forth in the opening part of this specification such that they apply considerably higher resistance forces in relation to a tensile loading in their longitudinal direction in relation to the material surrounding them, with the same length. The improvement is possible in the context of a new production process without a high level of additional complication and expenditure.

According to the invention that problem is solved in that the fibre edges formed by the fibre outer surfaces of the metal fibre and extending in the longitudinal direction of the fibre are in the form of edge surfaces oriented inclinedly relative to the fibre outer surfaces in the manner of a chamfer and said edge surfaces have projections forming anchoring heads in relation to the materials to be stabilised, consolidated or fastened.

The advantage achieved by the invention is essentially that those anchoring heads, of which there can be provided a multiplicity in the longitudinal direction of the metal fibre, in a situation involving a tensile loading, respectively apply individually high frictional forces in relation to the surrounding material so that a considerably higher load-carrying capability is achieved with the same fibre length overall.

In a preferred embodiment of the invention it is provided that the anchoring heads form anchor wedge surfaces increasing the cross-section of the fibre in the region of the edge surfaces, wherein the cross-section of the fibre in the apex region of the anchoring heads is of a substantially rectangular configuration.

In that respect it has further proven to be advantageous if the anchor wedge surfaces are oriented at an angle of 10° to 60° relative to the longitudinal direction of the fibre and – if made from strip material – are oriented inclinedly relative to the former starting material strip surface. It is particularly advantageous in that respect if in that case the anchor wedge surfaces are oriented at an angle of 15° to 30° relative to the longitudinal direction of the fibre which is used in concrete.

Usually the metal fibre – in particular the straight steel fibre used in concrete – will be so designed that the eight anchor wedge surfaces of an

anchoring head are arranged in axis-symmetrical relationship and symmetrically with respect to the apex of the anchoring head, that is to say at the same angle.

In the case of the metal fibre clip it is appropriate to increase the frictional forces at any event in one direction without in that case weakening the anchoring heads themselves, it can also be recommended that the anchor wedge surfaces of an anchoring head are arranged asymmetrically relative to the apex of the anchoring head, that is to say at unequal angles, wherein then advantageously the anchor wedge surface with the smaller angle faces towards the end that is closer thereto of the metal fibre, in the driving-in direction.

In accordance with the invention the edge surfaces can adjoin the fibre outer surface at an angle of 30° to 60° . Usually the orientation will be such that the edge surfaces adjoin the fibre outer surface at an angle of 45° . If production of the metal fibres from strip material is effected by way of a notch rolling process, the fibre outer surfaces are formed twice by the strip surface and twice by the fracture surface.

A kind of design configuration which has proven desirable is one in which the width of the fibre outer surface in the region between the anchoring heads is about 33% of the thickness or width of the fibre. That gives an approximately octagonal cross-section between the anchoring heads in the steel fibre for concrete.

In that respect it is generally the case that the metal fibre, considered in the longitudinal direction, can vary in particular in respect of its geometrical properties. Thus the anchoring heads can differ from each other in respect of shape and size; the edge surfaces between two respective anchoring heads can also be of differing configurations in respect of width and angular position, wherein also the spacing of the individual anchoring heads can be selected to be equidistant and also periodically or freely changing.

The starting material for the metal fibre can be suitably selected in respect of material strength and hardness to correspond to the respective purpose of use; therefore the entire range of strength from soft to hard is

considered for the starting material. The low strength range is rather indicated for the steel fibre for use in concrete while the high to very high strength range is indicated for the metal fibre clip.

Basically all suitable starting shapes are considered as the starting material for production of the metal fibre. It is also possible to use usual steel wire for that purpose. It is advantageous in regard to a simple and inexpensive production process however that the metal fibre is made from strip material by a notch rolling process with a tumbling process which if required follows, prior to the separating process. If steel fibres for use in concrete are produced from strip material by a notch rolling process then the steel fibre strand strip formed in that way is then separated. The anchoring means are produced by V-shaped interruptions in the notch noses of the notching roller. The wedge-shaped anchoring means are shaped on the one hand by the V-angles of the interruptions and by the selected depth of the V-shaped interruptions in relation to the notch depth. The V-angle affords the anchor wedge angle on the product. The size of the anchoring means is defined by the notch depth and the depth of the V-shaped interruptions. If for example the V-shaped interruption is deeper than the planned notch depth, then the apex of the anchor head becomes wider. The V-shaped interruptions are generally ground into the rolling tool parallel to the rolling tool axis at the desired spacing for the anchoring means. If it is considered to be useful the V-shaped interruptions can also be ground in a spiral shape. Separation of the steel fibre strand strips to form steel fibre strands can be implemented by a shearing operation following the respective notch bottom, wherein the anchoring means are relatively greatly deformed by a conventional shearing operation. It is therefore desirable for the separation process to be prepared by first implementing a tumbling process, with scratching of the anchoring heads in alignment with the individual notch bottoms. The steel fibre strands are then to be cut off to the desired steel fibre length. In the case of the steel fibre clip with anchoring means the process in accordance with DE 10 2008 034 250 should be used.

Usually the anchoring heads are arranged at all four edge surfaces and – with respect to the longitudinal direction of the fibre – at the same respective height. Equally however there is also the option of the anchoring heads being formed at mutually changing spacings or also only in pair-wise relationship at the edge surfaces of the top side and underside of the strip.

The latter is recommended in particular when the metal fibre is designed to form a clip, in which case then the anchoring heads are provided only at the two edge surfaces adjoining a fibre outer surface, wherein the ends are then angled in such a way to form the clip that the anchoring heads are disposed in mutually opposite relationship on the inside of the clip.

The invention is described in greater detail hereinafter by means of an embodiment by way of example illustrated in the drawing of a steel fibre for concrete; in the drawing:

Figure 1 shows a side view of a portion of a metal fibre according to the invention,

Figure 2 shows a plan view of the structure of Figure 1,

Figure 3 shows a section through the structure of Figure 1 along line C-C,

Figure 4 shows a section through the structure of Figure 1 along line D-D,

Figure 5 shows a section through the structure of Figure 1 along line B-B, and

Figure 6 shows a perspective view of the metal fibre.

The steel fibre illustrated in the drawing is intended for use in concrete and serves to improve the performance of the concrete in respect of a tensile, compression and shock loading. In that respect in the event of crack formation in the concrete the steel fibres are intended if possible to prevent the crack from spreading. The metal fibre clip (not shown in the drawing) which is bent in a U-shape is frequently used for example in the form of various connecting elements in relation to relatively soft and elastic

material such as for example wood in all variants and plastic material, in the building and construction trade and in the furniture industry.

More specifically the metal fibre which here in the embodiment is produced with the above-mentioned notch rolling process has fibre outer surfaces 1 which are oriented substantially at a right angle to each other, wherein the fibre edges 2 formed by the fibre outer surfaces and extending in the longitudinal direction of the fibre are in the form of edge surfaces 4 oriented inclinedly relative to the fibre outer surfaces 1 in the manner of a chamfer. Those edge surfaces 4 have projections forming anchoring heads 3 in relation to the materials to be stabilised or fastened.

As can also be seen from the drawing the anchoring heads 3, in the region of the edge surfaces 4, form anchor wedge surfaces 3.1, 3.2 increasing the cross-section of the fibre, wherein the cross-section of the fibre in the apex region of the anchoring heads 3 is of a substantially rectangular configuration, as can be seen from Figure 5. The apex region of the anchoring head 3 does not have to be in line form but can certainly be of a width of for example 0.03 mm. That is achieved for example by the V-shaped interruption in the notching noses in the notching procedure being somewhat deeper than the notch depth. The cross-sectional difference between the more or less octagonal fibre cross-section and the cross-section in the region of the anchoring head 3, depending on the respective notch depth, is approximately 25 % and is essential as a positively locking engagement for effective anchoring in relation to a tensile loading. The cross-sectional difference between the fibre cross-section and the cross-section at the anchoring head 3 is adjusted by the notch angle which practically is at 90° and the relative notch depth. If for example the notching is so deep that the oppositely disposed notch tips almost touch each other then the fibre cross-section becomes almost quadrangular or rectangular and in that case the cross-sectional difference becomes greater (up towards 50 %). In that case shear fractures then also occur some time in the region of between the notch tips, and those fractures indicate that the material is wearing out and are therefore not necessarily wanted.

The anchor wedge surfaces 3.1, 3.2 can be oriented at an angle of 10° to 60° relative to the longitudinal direction of the fibre, wherein in practice a smaller range for example in the region of 15° to 30° is rather used, as is also shown in the drawing in Figure 1.

5 As can be further seen there, in the case of metal fibres for use in concrete, the eight anchor wedge surfaces of an anchoring head are respectively arranged in axis-symmetrical relationship and symmetrically relative to the apex of the anchoring head, with respect to each other, that is to say at the same angle. If however – for example in the case of a clip
10 – there is a wish to increase the withdrawal forces without increasing the driving-in force for the clip into the material to be fastened to the same extent, then the anchor wedge surfaces 3.1, 3.2 of an anchoring head 3 can also be arranged asymmetrically relative to the apex of the anchoring head 3, that is to say at unequal angles, in which case then for example the
15 anchor wedge surfaces 3.1 are advantageously at a smaller angle relative to the end nearer to them of the metal fibre.

As can be seen in particular from Figure 3 the edge surfaces 4 adjoin the fibre outer surface 1 at an angle of 45° ; in principle however it is also possible in accordance with the invention for those edge surfaces 4 to
20 adjoin the fibre outer surfaces 1 at an angle of 30° to 60° , wherein the edge surface width is dependent on the notch depth.

The width of the fibre outer surfaces 1 in the region between the anchoring heads 3 is basically influenced by the material properties of the metal fibre and the production process, that is to say for example in the
25 case of starting material in strip form, the strip thickness, the tool design and the notch depth, and can be about 33% of the thickness or width of the fibre. In the region between the anchoring means, the aim sought in the case of the steel fibre for concrete is an approximately octagonal cross-section while in the case of the metal fibre clip it is mostly a rather
30 rectangular cross-section.

The conventional wire steel fibre of higher quality is made from relatively high-strength unalloyed steels. For a steel fibre for concrete, for which starting material in strip form is used, depending on the respective

purpose of use it is possible to use soft to hard starting material of steel of various qualities in order to produce same with a notch rolling process with a tumbling process which follows if required, as well as a separating and length-cutting process. Generally high-strength starting material is desired
5 for the metal fibre clip. That can be high-strength high-quality steel or also high-strength unalloyed or alloyed steel. In principle it is possible to use all materials if they have the appropriate properties.

In the illustrated embodiment the anchoring heads 3 are provided at all four edge surfaces 4; for particular situations of use however it is
10 equally conceivable to provide only individual ones of the edge surfaces 4 with anchoring heads 3. That is appropriate for example in a design configuration in the form of a clip where the anchoring heads 3 are provided only at the two edge surfaces 4 adjoining a fibre outer surface, wherein the ends are then angled to form the clip so that the anchoring
15 heads 3 are disposed in mutually opposite relationship only at the inside of the clip. In that way the clip, at its outside surface which is shaped in the form of a U-profile, does not have any projections which cause a problem and which possibly represent a risk of injury.

CLAIMS

1. A metal fibre having fibre outer surfaces which are oriented substantially at a right angle to each other, also with angled ends in the form of a clip, for stabilising, consolidating or fastening materials such as concrete, wood and the like, characterised in that the fibre edges (2) formed by the fibre outer surfaces (1) of the metal fibre and extending in the longitudinal direction of the fibre are in the form of edge surfaces (4) oriented inclinedly relative to the fibre outer surfaces (1) in the manner of a chamfer and said edge surfaces (4) have projections forming anchoring heads (3) in relation to the materials to be stabilised, consolidated or fastened.

2. A metal fibre according to claim 1 characterised in that the anchoring heads (3) form anchor wedge surfaces (3.1, 3.2) increasing the cross-section of the fibre in the region of the edge surfaces (4), wherein the cross-section of the fibre in the apex region of the anchoring heads (3) is of a substantially rectangular configuration.

3. A metal fibre according to claim 2 characterised in that the anchor wedge surfaces (3.1, 3.2) are oriented at an angle of 10° to 60° relative to the longitudinal direction of the fibre.

4. A metal fibre according to claim 2 characterised in that the anchor wedge surfaces (3.1, 3.2) are oriented at an angle of 15° to 30° relative to the longitudinal direction of the fibre.

5. A metal fibre according to one of claims 1 to 4 characterised in that the anchor wedge surfaces (3.1, 3.2) of an anchoring head (3) are arranged in axis-symmetrical relationship and symmetrically with respect to the apex of the anchoring head (3), that is to say at the same angle.

6. A metal fibre according to one of claims 1 to 4 characterised in that the anchor wedge surfaces (3.1, 3.2) of an anchoring head (3) are arranged asymmetrically, that is to say at unequal angles, wherein

advantageously the anchor wedge surface (3.1) with the smaller angle faces towards the end that is closer thereto of the metal fibre.

7. A metal fibre according to one of claims 1 to 6 characterised in that the edge surfaces (4) adjoin the fibre outer surface (1) at an angle of 30° to 60° .

8. A metal fibre according to one of claims 1 to 6 characterised in that the edge surfaces (4) adjoin the fibre outer surface at an angle of 45° .

9. A metal fibre according to one of claims 1 to 8 characterised in that the width of the fibre outer surface (1) in the region between the anchoring heads (3) is about 33% of the thickness or width of the fibre.

10. A metal fibre according to one of claims 1 to 9 characterised in that depending on the respective purpose of use it is made from soft to high-strength starting material.

11. A metal fibre according to one of claims 1 to 10 characterised in that it is made from strip material by a notch rolling process and separating process with a tumbling process which if required is disposed upstream of the latter.

12. A metal fibre according to one of claims 1 to 11 characterised in that the anchoring heads (3) are provided only in pair-wise relationship at not all edge surfaces (4).

13. A metal fibre according to one of claims 1 to 11 characterised in that in the configuration in the form of a clip the anchoring heads (3) are provided only at the two edge surfaces (4) adjoining a fibre outer surface (1), wherein the ends are so angled to afford the clip that the anchoring heads (3) are disposed in opposite relationship at the inside of the clip.