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(54) REINFORCING ELEMENT FOR DISPERSIVE REINFORCEMENT OF CONCRETE.

(57) A reinforcing element consists of an elongate metal body (1). At least two linear dimensions of the body (1) in its cross section are gradually changing along its length. Said dimensions change in a mutually inverse relationship.

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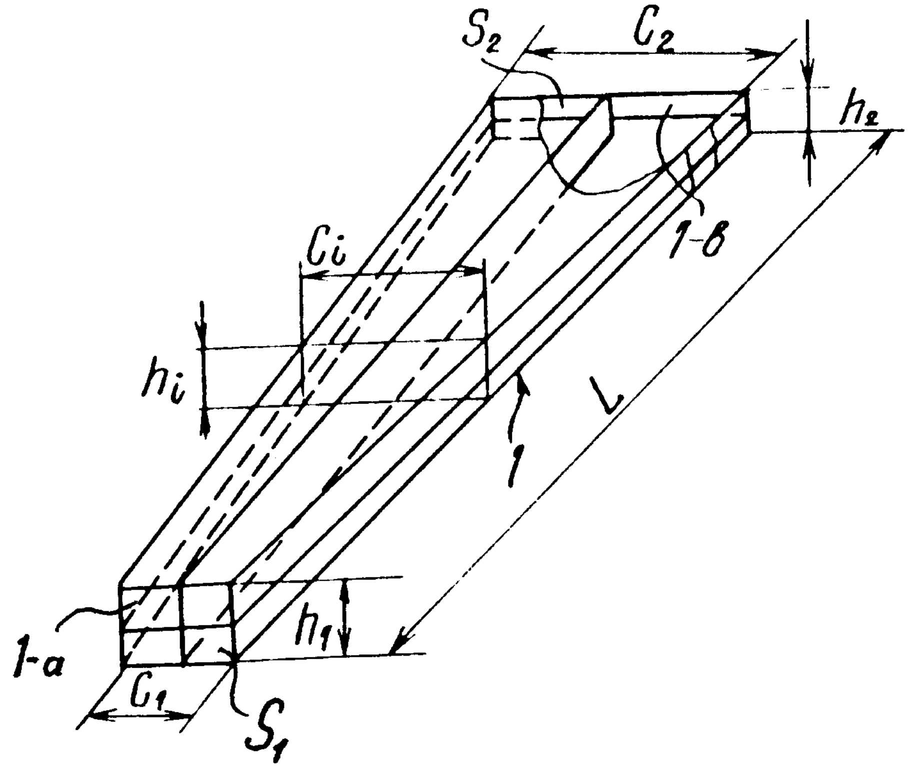

FIG.1

Field of the Invention

The present invention relates to construction materials and, more specifically, to reinforcing elements used for dispersion reinforcement of concretes.

Prior Art

Among the principal requirements to be met by reinforcing elements used for dispersion reinforcement of concretes are: -

high strength inasmuch as reinforced concrete structures incorporating reinforcing elements generally operate under conditions of alternating loads; and

high reliability of element retention in concrete, avoiding element displacements within concrete.

To meet said requirements, the reinforcing elements should be free from high-level stress concentrators, on the one hand, and, on the other hand, they should be fixed in place relative to the concrete with a force (F_f) such that whatever the operating conditions for the concrete and whatever the variations in the structure and composition of the concrete are there should be no reinforcing element displacements relative to the concrete.

As a rule, all types of reinforcing elements used at the present time have the form of elongated metal bodies with anchorage sections. In the process of reinforced concrete manufacture, elongated metal elements are distributed uniformly throughout the volume of the concrete and, in the case of cracks originating in the concrete, inhibit their propagating, taking up the load transmitted from the concrete. Retention of such reinforcing elements within concrete is by means of mechanical engagement between elements and concrete due to the presence of microirregularities on the surface of reinforcing elements, as well as through mechanical locking between said reinforcing elements and concrete owing to the presence of the aforesaid anchorage sections. Since mechanical engagement alone is frequently incapable of providing the necessary fixation force (F_f) to retain a reinforcing element within concrete, such reinforcing elements are generully provided with anchorage sections which permit of considerably increasing said fixation retention force.

There is known a reinforcing element for dispersion reinforcement of concretes (FR, B, 2061681), having the form of a wire length with variously shaped bent ends. The bent ends of the element make anchorage sections providing mechanical engagement between said element and concrete.

This type of reinforcing element is disadvantageous in having stress concentrators in the form of bent wire sections, this leading to lower reinforcing element strength. Besides, the mechanical locking force active between reinforcing element and concrete is based mainly on the concrete interacting with a relatively small area of the reinforcing element surface, namely that of the bent wire ends, which leads to higher stressess acting upon the bent wire sections. The result is still poorer reinforcing element strength.

Finally, bent wire ends make for aggregation of reinforcing elements when these are loaded into containers, transported, and so on, this calling for additional - and highly arduous - operations for separating said elements. Also the tendency of such reinforcing elements to aggregate has a negative effect upon the uniformity of their distribution in the concrete mix.

There are known reinforcing element designs, wherein that surface area of a reinforcing element mechanically locked with the concrete is considerably increased compared to the previous counterpart, with a view to increasing the force of reinforcing element retention in concrete.

Thus, there is known a reinforcing element (US, A, 3953953) in the form of a metal strip enlarged or bent (folded)at its ends. Compared to the previous counterpart, this type of construction enables a somewhat larger engagement surface area and locking effect between reinforcing element and concrete, reducing at the same time its tendency to aggregation with elements of the same type.

Another known reinforcing element (SU, A, 1353876) has the form of a metal strip C-shaped in cross-section, with one of its surfaces having a wavy profile (contour). At one of its ends, the strip is thickened (bulged) on the concave side.

This type of reinforcing element has a more extensive engagement surface with the concrete than in the previous counterpart.

However the last two reinforcing element designs described above feature relatively high stress concentrators, such as bent folded sections or bulges. Besides, making one of the reinforcing element surfaces wavy will also contribute to a higher stress level therein when operated as part of a reinforced concrete structure.

The aforesaid disadvantages will reduce the strength of reinforcing elements when these are operated as part of a reinforced concrete structure, reducing thereby the reliability of this same reinforced concrete structure.

Disclosure of the Invention

The present invention is based upon the objective of providing a reinforcing element for dispersion reinforcement of concretes, which reinforcing element would have a form such as could ensure its reliable retention within concrete and provide high reinforcing element strength.

The objective as stated above is achieved by providing a reinforcing element for dispersion reinforcement of concretes, comprising an elongated metal body with anchorage sections, wherein,according to the invention, the elongated metal body is of a form such that at least two of its cross-sectionally linear dimensions gradually change all over its length, with the changes in said dimensions being inversely related to each other.

The anchorage sections in this reinforcing element are those having cross-sectionally linear dimensions variable along the reinforcing element length.

This form of an elongated metal body assures high reliability for the retention of the reinforcing element in the concrete, considering that this elongated body has the form of a two-sided wedge. To assure said high retention reliability in this case, there is no need for anchorage sections such that would make stress concentrators.

Besides, any section of such a reinforcing element, however small, will be in engagement with concrete, and, given an equal fixation force, this will lead to higher reinforcing element strength, as compared to the previously described counterpart.

In one of the embodiments of the invention, the elongated metal body may have a rectangular form in cross-section, with the width and height of this rectangular section inversely changing relative to each other along the elongated body length.

This reinforcing element embodiment is the easiest one for fabrication.

It is convenient for the cross-sectional areas at the ends of an elongated metal body of rectangular form in cross-section to be equal to each other.

The equality of the cross-sectional areas at the ends of the elongated metal body is optimal from the point of view of the possibility of using reinforcing elements of minimal length inasmuch as the reinforcing element in this case is retained from displacement along its longitudinal axis in the two directions with an equal force (F_f) which can be selected close to the minimum allowable value. Decreasing the reinforcing element length will lead to material savings and will reduce the tendency of reinforcing elements to aggregate.

In one of the embodiments of the invention, the elongated metal body may have the form of a strip of constant width and bent cross-sectionally, the curvature of the cross-sectional contour of the strip decreasing all along the strip length down to one of its ends.

This embodiment enables the use of metal cutting wastes as reinforcing elements.

Brief Description of the Drawings

The aforesaid advantages and specific features of the present invention will become more fully apparent through studying the following detailed description of its embodiment, taken in conjunction with the accompanying drawings, wherein:

FIG.1 is an axonometric view illustrating a reinforcing element for dispersion reinforcement of concretes, according to the invention;

FIG.2 illustrates schematically the operation of the reinforcing element in inhibiting the propagation of microcracks in concrete;

FIG.3 is an axonometric view illustrating another embodiment of the reinforcing element, and

FIG.4 illustrates schematically the operation of the reinforcing element shown in FIG.3 in inhibiting the propagation of microcracks in concrete.

Best Mode to Carry out the Invention

The reinforcing element for dispersion reinforcement has the form of an elongated prismatic metal body 1 which has a rectangular form in cross-section in one of its embodiments (FIG.1). The width C_i of said rectangular section increases (from C_1 to C_2) while the height h_i of said section decreases (from h_1 to h_2) from one end 1-a of the body 1 to its other end 1-b. The cross-sectional area S_1 at the end 1-a of the body 1 is equal to the cross-sectional area S_2 at the end 1-b. However, in one of the embodiments, the areas S_1

and S_2 may not be equal to each other. But, as previously mentioned, the equality of the areas S_1 and S_2 is optimal from the point of view of the possibility of using reinforcing elements of minimal length, which provides material savings and reduces the tendency of reinforcing elements to aggregate. The value of slope of the longitudinal ribs of the elongated body 1 relative to its longitudinal axis, the length of the body 1, and the value of the areas S_1 and S_2 may be easily selected by experimentation, based on the possibility of obtaining optimal values for such parameters as the reliability of retention of reinforcing elements in concrete, high reinforcing element strength, and the uniformity of distribution of reinforcing elements in concrete mixes by way of eliminating the tendency of reinforcing elements to aggregation.

In one of the embodiments of the invention, illustrated in FIG.3, the elongated metal body 1 of the reinforcing element is fabricated in the form of a strip of constant width and bent cross-sectionally. In this case the radius of curvature, R_i, of the cross-sectional contour of the strip gradually increases (the curvature, thus, gradually decreasing) from the value R_1 at one end 1-a of the body 1 to the value R_2 at its other end 1-b. As a result, one linear dimension, l_i, in the cross-section of the body 1, dependent on said strip curvature, increases from l_1 to l_2 along the strip length while the other linear dimension, d_i, decreases in the same direction. The values R_1 and R_2, the transverse dimensions of the strip, and the length of the body 1 may be easily selected by experimentation, based on the possibility of obtaining optimal values for such parameters as the reliability of retention of reinforcing element in concrete, high reinforcing element fatigue strength, and the uniformity of distribution of reinforcing elements in concrete mixes by way of eliminating the tendency of reinforcing elements to aggregate. The reinforcing element illustrated in FIG.3 may be fabricated by, e.g., milling a steel slab at a pre-selected slope of the front cutting edge of the milling tool.

In the fabrication of reinforced concrete structures, the necessary amount of reinforcing elements are introduced into a concrete mass to be mixed in any known type of mixer, with the reinforcing elements being uniformly distributed throughout the volume of the concrete mass.

In a reinforced concrete structure, the proposed reinforcing element functions as follows. A microcrack 3 arising in a concrete 2 (FIGS.2 and 4) initiates the operation of those reinforcing elements crossing the microcrack 3 and having a predominant direction coinciding with the direction of main stretching stresses P (shown by arrows). These reinforcing elements inhibit the propagation of the crack, taking up the load transmitted from the concrete 2, the reinforcing elements fabricated in the form of elongated metal bodies 1 are retained here in position owing to mechanical engagement between said elements and the concrete 2, due to the presence of microirregularities (not shown) on the surfaces of the reinforcing elements, as well as due to the anchorage sections of said elements being mechanically engaged locked with the concrete 2. In the reinforcing element construction illustrated in FIG.1, such anchorage sections are provided by the longitudinal edges of the elongated body 1, while in the construction illustrated in FIG.3 the anchorage sections are its longitudinal ribs and the sides defined by said ribs. Since engagement locking between reinforcing elements and concrete is provided by any sections, however small, all over the length of the reinforcing elements, the strength of the reinforcing elements increases, owing to the absence of stress concentrators, as said elements continue to function as part of the concrete mix.

The strength properties of reinforced concrete using the proposed reinforcing element were determined on specimens sized 4x4x16 cm.

Specimens were prepared using a source mix of the following composition (wt. %):

cement	25
sand	55
dispersion-type reinforcing elements	10
water	10

The volume concentration (M_v) of reinforcing elements in the source mix was 3.0 per cent.

In the process of testing, conventional techniques were used to determine the ultimate stresses for specimens in flexure (R_1) and in compression (R_2), characterizing the strength of the reinforced concrete, hence that of the reinforcing element. Also, the number of alternating load cycles (N) was determined, at a load equal to 0.6 breaking load.

The above parameters (R_1 and R_2) were also determined for specimens containing reinforcing elements described in FR, B, 2061681 and in SU, A, 1353876.

The test results obtained on said specimens are tabulated below.

Table

Specimen Nos.	M_v, %	Concrete density, ρ, kg/m^3	R_1, kgf/cm^2	R_2, kgf/cm^2	Number of cycles, N
1. Reinforcing elements in the form of bent strips	3.0	2330	168	457	-
2. Reinforcing elements of rectangular form in cross-section	3.0	2330	191	525	$2.5 \bullet 10^4$
3. No reinforcing elements	-	2230	85	480	-
4. Reinforcing elements according to FR, B, 2061681	2.0	-	-	-	$1.4 \bullet 10^4$
5. Reinforcing elements according to SU, A, 1353876	3.0	2300	124	283	-

Industrial Applicability

The proposed reinforcing element can be used for fabrication of building structures and products from composite materials, e.g. concrete mixes reinforced with steel fibres.

Claims

1. A reinforcing element for dispersion reinforcement of concretes, comprising an elongated metal body (1) with anchorage sections and **characterized** in that the elongated metal body is of a form such that at least two of its cross-sectionally linear dimensions (C_i and h_i or d_i and l_i) gradually change all over its length, with the changes in said dimensions being inversely related to each other.

2. A reinforcing element as defined in Claim 1, **characterized** in that the elongated metal body (i) has a rectangular form in cross-section, with the width (C_i) and height (h_i) of said rectangular section inversely changing relative to each other along the elongated body length.

3. A reinforcing element as defined in Claim 2, **characterized** in that the cross-sectional areas at the ends (1-a and 1-b) of the elongated metal body are equal to each other.

4. A reinforcing element as defined in Claim 1, **characterized** in that the elongated metal body (1) has the form of a known per se strip having constant width and bent cross-sectionally, the curvature of the cross-sectional contour of the strip decreasing all along the strip length down to one of its ends (1-a or 1-b).

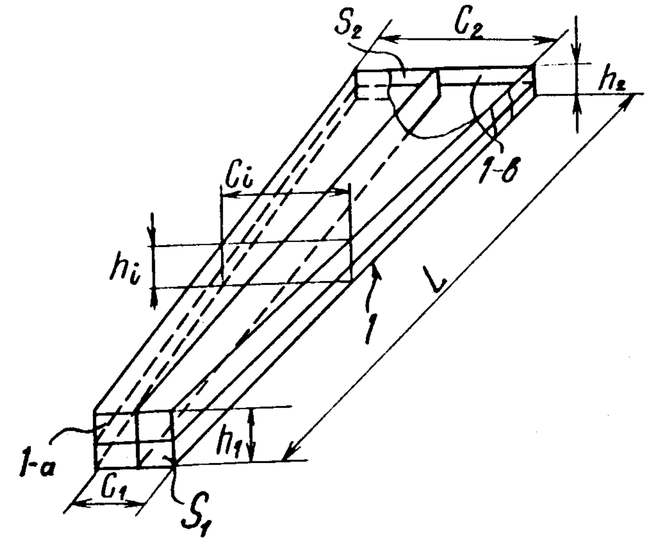

FIG.1

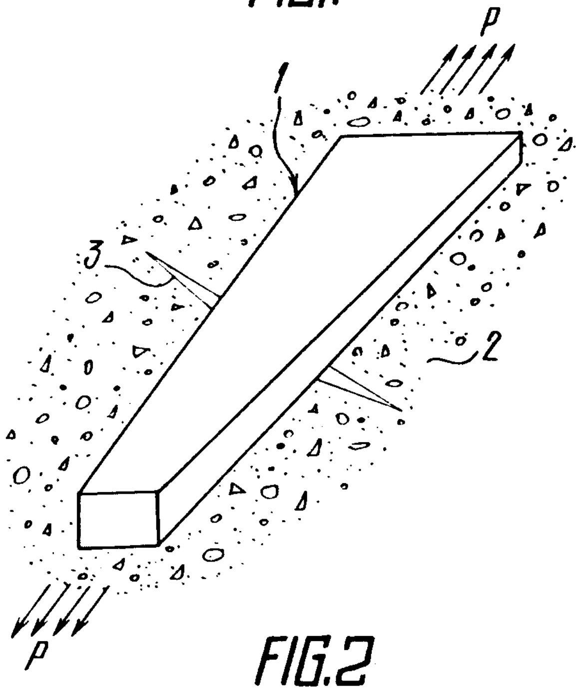

FIG.2

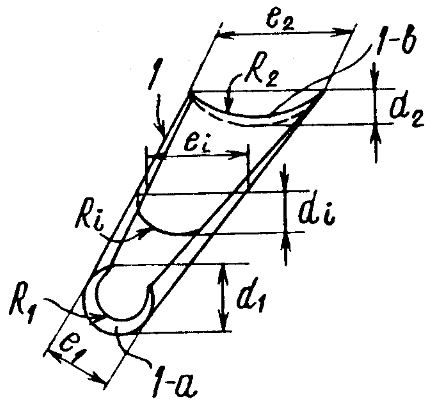

FIG.3

FIG.4

INTERNATIONAL SEARCH REPORT

International Application No PCT/SU90/00175

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.^{5} : E04C 5/03

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
Int. Cl.^{5}	E04C 5/00-5/065

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	SU, A1, 1213156 (Kombinat "Stroiindustria" Glavmospromstroimaterialov i Moskovsky aviatsionny tekhnologichesky institut im K.E. Tsiolkovskogo) 23 February 1986 (23.02.86), the description, the claims	1,3,4
A	SU, A1, 1213157 (Chelyabinsky politekhnichesky institut im Leninskogo Komsomola), 23 February 1986 (23.02.86), the claims, the description	1
A	SU, A1, 1479590 (Volkhovsky kombinat stroitelnykh Konstruktsy), 15 May 1989 (15.05.89), claim 1, page1, lines 10,15,20	1
A	FR, A1, 2393896 (MICHELIN & CIE), 5 January 1979 (05.01.79), figure 2, page 2, lines 20-25	1
A	DE, A1, 3341957 (HUFNAGL WALTER), 30 May 1984 (30.05.84), fig. 1,2 pages 6-10	1

* Special categories of cited documents: [10]

- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
15 March 1991 (15.03.91)	25 April 1991 (25.04.91)
International Searching Authority	**Signature of Authorized Officer**
ISA/SU	