(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 853 169 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
15.07.1998 Bulletin 1998/29

(21) Application number: **96932106.6**

(22) Date of filing: **16.09.1996**

(51) Int. Cl.^{6}: **E04C 5/06**, E04G 21/12

(86) International application number:
PCT/RU96/00261

(87) International publication number:
WO 97/12102 (03.04.1997 Gazette 1997/15)

(84) Designated Contracting States:
CH DE LI

(30) Priority: **27.09.1995 RU 95116603**

(71) Applicants:
- **Dailov, Alexandr Alexeevich**
Moscow, 105179 (RU)
- **Kishkin, Vladimir Alexeevich**
Moscow, 105179 (RU)

(72) Inventors:
- **Dailov, Alexandr Alexeevich**
Moscow, 105179 (RU)
- **Kishkin, Vladimir Alexeevich**
Moscow, 105179 (RU)

(74) Representative:
Zellentin, Rüdiger et al
Patentanwälte
Zellentin & Partner
Zweibrückenstrasse 15
80331 München (DE)

(54) METHOD OF STRENGTHENING REINFORCED CONCRETE STRUCTURES (VARIANTS)

(57) The proposed method of strengthening reinforced concrete structures pertains to construction and improves resistance to splitting, breaking and bursting of reinforced concrete structures. It can be implemented in either of two variants. In the first variant involving the use of reinforcing and concreting elements in formwork, the reinforcing and concreting elements used are a longitudinal and a transverse helical element in a free untensioned state; transverse spirals are fitted in the windings of the longitudinal helical element, the axes of the longitudinal and transverse helical elements are aligned to be mutually perpendicular, and are then spaced evenly and secured throughout the volume of the three-dimensional casing of the reinforced concrete structure, or alternatively the casing is formed from a three-dimensional helical matrix, the three-dimensional casing is concreted to create conditions under which when any stretching forces are applied in any direction reinforcement is produced which is perpendicular to the planes of the principal forces. In the second variant involving the use of reinforcing and concreting elements in formwork, the reinforcing elements used are a lamellar element with projections in a free untensioned state, and concreting is done to create conditions for moulding the casing of the reinforced concrete structure from the lamellar element.

EP 0 853 169 A1

Description

Technical Field

The present invention relates to the art of construction and, more specifically, it concerns methods of strengthening reinforced concrete structures providing protection both against static loads brought about in the process of bending and compression and under the action of local dynamic loads caused by application of breaking tools and piercing effected by means of small arms, and also under the action of an explosion, seismic and seismic-impact loads.

Background of the Invention

Known in the prior art is a method of strengthening reinforced concrete structures and in particular, hollow core slabs, including the placement of reinforcement bars in the longitudinal and transverse directions, the reinforcement bars of the longitudinal direction being placed in a fan-shaped manner relatively to the hollow core slab axis of symmetry passing through the hollow, while the reinforcement bars of the transverse direction are placed normal to the same axis of symmetry above the reinforcement bars of the longitudinal direction and are connected therewith at the points of intersection and thereafter the concreting is accomplished.

(SU, A No. 1738968).

A disadvantage of said method of strengthening reinforced concrete structures resides in that the labor intensity needed for reinforcement is high because of a large scope of required welding operations due to which there exists a possibility of the overburning of reinforcement bars, whereas the effectiveness of taken dynamic loads and especially of local penetrating action of breaking tools, piercing effected with the aid of small arms or by an explosion wave is not high.

Also known in the prior art is a prestressed reinforced concrete slab for a precast airdrome or road pavement in, which there has been realized a method of strengthening based on the application of the prestressed reinforcement bars placed in the longitudinal direction at one or two levels throughout the slab thickness, the reinforcement bars placed in the transverse direction at two levels throughout the slab thickens and concreting in fit-in forms with a subsequent stripping thereof.

(GOST 25912.0-83 - GOST 25912.3-83. Prestressed Reinforced Concrete Slabs for Airdrome Pavement M. Publishing House of Standards, 1984, p. 20).

Said prestressed reinforced concrete slab for a precast airdrome or road pavement and the method of said slab manufacture make it possible to reduce consumption of the reinforcement and to provide resistance to dynamic loads, however when the pavement is damaged under the action of breaking tools, small arms or an explosion the prestressed bar reinforcement contributes to development of cracks in the prestressed reinforced concrete slab which brings the latter to failure.

There is known a method of strengthening reinforced concrete structures aimed at protection of an reinforcement frame of building structures against dynamic loads. incorporating concreting, prestressed longitudinal spiral and longitudinal line reinforcement, the line reinforcement being placed inside of angle spiral reinforcement, while in the cross-section of a building structure there are formed two closed concreted zones, of which the external one is formed along the perimeter of the cross-section and the internal zone is formed at the center of the building structure, and the relationship of an area of the external closed zone S_1 to the internal zone S_2 is selected equal to S_1:S_2 -0.7 - 3.5, respectively.

(RU, A, No. 2056491).

Although said method improves protection of the frame of building strutures against the seismic-impact action, however it fails to protect the frame against local penetration accomplished by means of breaking tools or a pinpoint explosion.

There is known one more method of strengthening reinforced concrete structures, incorporating concreting and application of a sheet reinforcement in the form of a metal strip with lugs, which before concreting is deformed (stretched), the bent-up triangular lugs being made by way of punching triangular slits in the metal strip.

(DE, A, No. 825002).

Said method is characterized by a reduced bonding of the reinforcement with concrete which, in combination with a prestressed state, leads to increase in sensitivity of the structure to piercing action effected by means of breaking tools, small arms or a pinpoint explosion.

The closest prior art of the invention both in technical concept and achieved results is a method of strengthening reinforced concrete structures, including application of reinforcement elements in a prestressed state and concreting in forms, the prestressed reinforcement disposed both in longitudinal and transverse directions being placed in a taut state in the form.

(Prestressed Pavements for Airdromes and Roads by V.S. Raiev-Bogoslovsy et al. M. "Transport", 1972, p. 52, p. 200).

However, the reinforced concrete structure manufactured according to this method, while taking up local dynamic loads normal to said reinforced concrete structure fails to prevent the destruction thereof under the action of damage caused by piercing effected by breaking tools, small arms or a pinpoint explosion, and the presence of the prestressed reinforcement only facilitates the destruction.

Disclosure of the Invention

The present invention is essentially aimed at providing reinforced concrete structures resistant to spalling, breaking and explosions, improving resistance to formation of cracks in concrete under the action of tension stress of arbitrary orientation, preventing premature destruction of concrete from a local damage caused by penetrating action of breaking tools, piercing action of small arms or a pinpoint explosion, as well as at reducing the scope of welding operations, cutting down the labor input improving economy of electric power and simplifying the assembly procedures.

The subject-matter of the invention resides in that in a method of strengthening the reinforced concrete structures in accordance with a first alternative embodiment in which the use is made of reinforcing elements and concreting in forms, according to the invention the longitudinal and transverse continuous spiral reinforcement in a free nonprestressed state is used as reinforcing elements, the transverse spirals being inserted in coils of the longitudinal spiral reinforcement, mutual perpendicularity of axes of the longitudinal and transverse reinforcement spirals is insured, the latter are uniformly and fixedly distributed throughout the volume of a three-dimensional frame of the reinforced concrete structure, the frame with the spiral reinforcement or made of the spiral reinforcement is placed in the form which is filled with a concrete mix and the latter is cured therein until a complete bonding of the concrete mix with the spiral reinforcement is obtained, providing conditions in which the reinforcement normal to areas of the main stresses gets under the action of tension stresses of any kind and arbitrary orientation and making it possible to prevent premature development of cracks in concrete and improve the resistance thereof to spalling, breaking and explosions. According to a second alternative embodiment of the invention a sheet reinforcement with lugs in a free nonprestressed state is used as reinforcement elements which are placed in the form, the latter is filled with the concrete mix which is cured until a complete bonding of the concrete mix with the sheet reinforcement and with the lugs is obtained, thus making it possible to provide conditions for forming a frame of the reinforced concrete structure from the sheet reinforcement and prevent premature development of cracks in concrete, as well as to provide resistance to spalling, breaking and explosions.

Combination of two technical solutions into one patent application is associated with the fact that the two given methods are used for solving one and the same problem, viz. providing resistance of the reinforced concrete structure to spalling, breaking and explosions, improving resistance to formation of cracks in concrete under the action of tension stresses of arbitrary orientation, preventing premature destruction of concrete from a local damage caused by penetrating action of breaking tools, piercing action of small arms or a pinpoint explosion, substantially in one and the same way, i.e. by strengthening the reinforced concrete structures effected by using the free nonprestressed reinforcement and concreting in the forms.

The difference of one alternative embodiment from the other one resides in the fact that in the first alternative embodiment the free nonprestressed longitudinal and the transverse spirals are used as the reinforcement, the transverse spirals being inserted in coils of the longitudinal spiral reinforcement with the provision of mutual perpendicularity of axes thereof, the longitudinal and transverse spirals are uniformly and fixedly distributed throughout the volume of a three-dimensional frame of the reinforced concrete structure or a three-dimensional frame is formed from the spiral reinforcement. In the second alternative embodiment a sheet reinforcement with lugs in a free nonprestressed state is used as reinforcing elements and in the process of concreting conditions are provided for forming the frame of the reinforced concrete structure from the sheet reinforcement. Such a difference between the methods prevents the latter from being acknowledged as one technical solution. The features characterizing the used kinds of the reinforcement are not equivalent, in so far as their selection is associated with alteration in the methods of reinforcement.

These methods comply with requirements for combining the inventions into a group representing versions of solving one problem.

Combination of essential features presented hereinbefore in both versions is aimed at achievement of technical results and is in cause-and-effect relation therewith, as it allows for:

- increasing resistance of the reinforced concrete structure to spalling, breaking and explosions;
- improving resistance to development of cracks under the action of the tension stresses of arbitrary orientation;
- preventing premature destruction of concrete from damage caused by the penetrating action of breaking tools, small arms or a pinpoint explosion;
- reducing the scope of welding operations;
- cutting down the labor input and increasing economy of the electric power, as well as simplifying the assembly procedures.

In addition, the invention is industrially applicable, as it may be used in construction.

Thus, it may be concluded that the claimed technical solution complies with the requirements of patentability of the invention.

Brief Description of the Drawings

The invention will now be described in detail with reference to the accompanying drawings, wherein:

Fig. 1 illustrates a reinforced concrete structure in the form of a single-layer protective barrier with spiral reinforcement:
Fig. 2 illustrates a reinforced concrete structure in the form of a double-layer protective barrier with spiral reinforcement:
Fig. 3 illustrates a reinforced concrete structure in the form a protective barrier with a single-sheet reinforcement and with lugs;
Fig. 4 illustrates a reinforced concrete structure in the form of a double-layer protective barrier with spiral reinforcement and with lugs ;
Fig. 5 illustrates a reinforced concrete structure in the form of a triple-layer protective barrier with spiral reinforcement.

Best Mode of Carrying Out the Invention

Embodiment of the claimed versions of a method for strengthening the reinforced concrete structures will become more apparent with reference to devices presented in the drawings, wherein Figs 1 and 2 illustrate the devices pertinent to the first version of a method for strengthening the reinforced concrete structures and Figs 3 through 5 illustrate the same pertinent to the second version of a method for strengthening the reinforced concrete structures.

Example 1. A reinforced concrete structure in the form of a single-layer protective barrier with a free nonprestressed spiral reinforcement (Fig.1).

The reinforced concrete structure in the form of a single-layer protective barrier with the free nonprestressed spiral reinforcement incorporates a three-dimensional frame 1, a longitudinal spiral reinforcement 2, a transverse spiral reinforcement 3 installed inside the spirals 2 with the provision of mutual perpendicularity of axes thereof and with interconnection of the spirals 2 and 3 for creating the effect of binding, and a concrete 4.

Assembly of the single-layer protective barrier with the spiral reinforcement 2 and 3 is effected in the following manner.

At first there is welded the three-dimensional frame 1, wherein the separate longitudinal spirals 2 in a free nonprestressed state are installed and interconnected by way of inserting the transverse spirals 3 in coils of the aforementioned separate longitudinal spirals 2, with the provision of mutual perpendicularity of axes thereof and forming of a three-dimensional reinforced concrete cage. The assembled frame 1 with the longitudinal spiral reinforcement 2 and the transverse spiral reinforcement 3 are placed in the form (not shown in drawings) and the latter is filled with a concrete mix. The frame 1 with the spirals 2 and 3 is cured until a complete bonding of the concrete 4 with the reinforcement is attained. Thereafter the form is stripped and the concreted frame 1 with the spirals 2 and 3 is extracted therefrom. When the three-dimensional frame 1 is manufactured from the reinforcement spirals 2 and 3 the operations of manufacturing the separate frame 1 and placing it into the form are not envisaged in this alternative method of strengthening the reinforced concrete structures. The manufactured protective barrier is ready for use.

The reinforced concrete structure in the form of a single-layer protective barrier is functioning in the following manner.

When the reinforced concrete structure is being crushed by means of bench tools or under the action of a piercing projectile, or a pinpoint explosion destruction of the concrete 4 is initiated by splitting cracks propagating from the head of a piercing object or by spalling cracks on the back side of the barrier caused by a reflected tension wave. Premature formation of cracks is prevented by the coils of the spirals 2 and 3 installed in a free nonprestressed state in the three-dimensional frame 1 or in the three-dimensional frame made from the spirals 2 and 3, as in any arbitrarily oriented section, there are always present fibers of the reinforcement from the spirals 2 and 3 arranged normal to areas of the main stresses. The lack of a prestressed spiral reinforcement in the reinforced concrete structure prevents further development of cracks in the concrete 4 caused by the penetrating action of bench tools or a projectile, or a pinpoint explosion.

Example 2. A reinforced concrete structure in the form of a double-layer protective barrier with the spiral reinforcement (Fig.2).

The reinforced concrete structure in the form of a double-layer protective barrier with a free nonprestressed spiral reinforcement incorporates a three-dimensional metal frame 1, a longitudinal spiral reinforcement 2, a transverse spiral reinforcement 3 installed inside the longitudinal spirals 2 with the provision of mutual perpendicularity of axes thereof and with interconnection of the aforementioned spirals for creating the effect of binding, and a concrete 4.

Assembly of the double-layer protective barrier with the spiral reinforcement is accomplished in the following manner.

At first there is welded the three-dimensional frame 1, in which two layers of the spiral reinforcement are installed. Each layer of the reinforcement is assembled from the separate longitudinal spirals 2 which are interconnected by way of inserting the transverse spirals 3 into the coils of aforementioned separate longitudinal spirals 2 with the provision of mutual perpendicularity of axes thereof and forming a three-dimensional reinforced concrete cage. The assembled frame 1 with the longitudinal spiral reinforcement 2 and the transverse spiral reinforcement 3 are placed in the form (not shown in drawings) which is filled with a concrete mix. The frame 1 with the spirals 2 and 3 is cured until a complete bonding of the concrete 4 with the reinforcement is attained. Thereafter the form is stripped and the ready-for-use protective barrier is extracted therefrom.

When a three-dimensional frame is manufactured from the reinforcement spirals 2 and 3 the operations of manufacturing the separate frame 1 are not envisaged in this alternative method. Assembly of the protective barrier with the three-dimensional frame made of the reinforcement spirals (not shown in drawings) is effected in the following manner. The three-dimensional frame is assembled from a free nonprestressed reinforcement in the form, then the form is filled with concrete which is cured until a complete bonding of the concrete with the reinforcement is attained. Thereafter the form is stripped and the ready-for-use protective barrier is extracted therefrom.

The reinforced concrete structure in the form of a double-layer protective barrier functions in much the same way as in the Example 1 only it withstands more intensive loads.

<u>Example 3</u>. A reinforced concrete structure in the form of a protective barrier with a free nonprestressed single-sheet reinforcement with lugs (Fig.3).

The reinforced concrete structure in the form of the protective barrier with a free nonprestressed single-sheet reinforcement incorporates a metal sheet 5 with lugs 6 turned in one direction a concrete 4 and a form 7.

The protective barrier with the single-sheet reinforcement is assembled in the following manner. At the first step the lugs 6 turned in one direction are stamped in the metal sheet 5, and the the sheet reinforcement 5 with the lugs 6 is placed in a free nonprestressed state in the form (not shown in drawings), with the lugs 6 facing down, thereafter the concrete 4 is delivered by means of a concrete pump (not shown in drawings) in the form between the sheet 5 with the lugs 6 and form 7 is cured until a complete hardening of the concrete 4 and its bonding with the sheet 5 and the lugs 6 are attained. Then the form is stripped and the ready-for-use protective barrier is extracted therefrom.

The protective barrier with the free nonprestressed single-sheet reinforcement with the lugs functions in the following manner. When a reinforced concrete structure is being crushed by means of bench tools or under the action of a piercing projectile, or a pinpoint explosion destruction of the concrete 4 is initiated by splitting cracks proprogating from the head of a piercing object or by spalling cracks on the back side of the barrier caused by a reflected tension wave. Premature formation of the spalling cracks is prevented by the free nonprestressed sheet reinforcement 5 with the lugs 6, as it takes up the tension stresses occurring in the reflected tension wave on the back side of the barrier, whereas the lack of the prestressed sheet reinforcement 5 prevents further devlopment of cracks in the concrete 4 caused by damage done under the piercing action of bench tools, or a projectile, or a pinpoint explosion.

<u>Example 4</u>. A reinforced concrete structure in the form of a protective barrier with a free nonprestressed double-sheet reinforcement with lugs (Fig.4).

The reinforced concrete structure in the form of the protective barrier with the double-sheet reinforcement incorporates upper and lower metal sheets 5 with lugs 6 directed opposite to one another and a concrete 4.

The protective barrier with the double-sheet reinforcement is assembled in the following manner. At the first step the lugs 6 are stamped on one side of the metal sheets 5, then the sheet reinforcement 5 with the lugs 6 is placed in a free nonprestressed state into the form (not shown in drawings) with the lugs 6 directed opposite to one another, then the concrete is delivered by means of a concrete pump (not shown in drawings) in the form between the sheets 5 and is cured until a complete bonding (hardening) of the concrete 4 and forming of the frame from the sheet reinforcement 5 are attained. Then the form is stripped and the ready-for-use protective barrier is extracted therefrom.

The protective barrier with the free nonprestressed double-sheet reinforcement with the lugs functions in the following manner. When the reinforced concrete structure is being crushed by means of bench tools or under the piercing action of a projectile, or a pinpoint explosion destruction of the concrete 4 is initiated by splitting cracks propagating from the head of a piercing object or by spalling cracks on the back side of the barrier caused by a reflected tension wave. Premature formation of the spalling cracks is prevented by the free nonprestressed sheet reinforcement 5 with the lugs 6, as it takes up tension stressed occurring in the reflected tension wave on the back side of the barrier, whereas the lack of the prestressed sheet reinforcement 5 with the lugs 6 prevents further development of cracks in the concrete 4 caused by damage done under the piercing action of bench tools, or a projectile, or a pinpoint explosion.

<u>Example 5</u>. A reinforced concrete structure in the form of a protective barrier with a free nonprestressed triple-sheet reinforcement with lugs (Fig.5).

The protective barrier with the triple-sheet reinforcement comprises two extreme metal sheets 5 with unidirectional lugs 6 directed opposite to one another, and one central sheet 8 with lugs 9 directed towards different sides, two channels 10 and 11 between the upper sheet 5 and the central sheet 8, as well as between the lower sheet 5 and the central sheet 8 respectively a concrete 4 in the channels 10 and 11.

The protective barrier with the triple-sheet reinforcement is assembled in the following manner. At the first step the lugs 6 are stamped on one side of the metal sheets 5, then the lugs 9 directed towards opposite sides are stamped on the central sheet 8. Then the sheet reinforcement 5 with the lugs 6 is placed in a free nonprestressed state into the form (not shown in drawings) with the lugs 6 directed opposite to one another, thereafter installed between the sheets 5 is the central sheet 8 with the lugs 9 which are guided into gaps free at the lugs 6 of the sheets 5. And both the extreme sheets 5 with the lugs 6 and the central sheet 8 with the lugs 9 are placed into the form in a nonprestressed state. Thereafter the concrete mix is delivered by means of a concrete pump (not shown in drawings) in the channels 10 and 11 between the sheets 5 and 8, and is cured until a complete bonding (hardening) of the concrete 4 in the channels 10 and 11 with the sheets 5 and 8, as well as with the lugs 6 and 9, and the formation of the frame from the reinforcement sheets 5 and 8 are attained,

The reinforced concrete structure in the form of a protective barrier with the free nonprestressed triple-sheet reinforcement with the lugs functions in the following manner. When the reinforced concrete structure is being crushed by means of bench tools or under the piercing action of a projectile, or a pinpoint explosion destruction of the concrete 4 in the channel 10 is initiated by splitting cracks propagating from the head of a piercing object or by spalling cracks on the back side surface of the central sheet 8 caused by a reflected tension wave which in its turn may cause splitting cracks in smaller volumes in the concrete 4 in the channel 11 and insignificant spalling cracks on the back side surface of the barrier caused by the reflected tension wave. Premature destruction of the barrier from damage caused by a piercing action of bench tools, a projectile or a pinpoint explosion is prevented by the free nonprestressed reinforcement sheets 5 and 8 with the lugs 6 and 9 which hinder formation and propagation of the splitting and spalling cracks.

Industrial Applicability

The application of the claimed invention will make it possible to raise 2 or 3 times as much the resistance of reinforced concrete structures to spalling, breaking and explosions at the expense of improving the resistance to formation of cracks of arbitrary orientation in concrete, excluding any possibility of their development in concrete from damage caused by the piercing action of bench tools or a projectile, or a pinpoint explosion, decreasing the reinforcement ratio by 1.5-2.0 times, cutting down the scope of welding operations by 30-40 %, and as a consequence to cut down the consumption of electric power and simplify the assembly procedures for reinforced concrete structures.

Claims

1. A method of strengthening reinforced concrete structures incorporating the application of reinforcement elements and concreting in forms, **characterized** in that longitundinal and transverse continuous reinforcement spirals in a free nonprestressed state are used as reinforcements elements, the transverse spirals being inserted in coils of the longitudinal spiral reinforcement with the provision of mutual perpendicularity of axes of the longitudinal and transverse reinforcement spirals which are uniformly and fixedly distributed throughout the volume of a three-dimensional frame of the reinforced concrete structure, the frame with the spiral reinforcement or made of the spiral reinforcement is placed in the form filled with a concrete mix which is cured therein until a complete bonding of the concrete mix with the spiral reinforcement is attained, thus providing conditions in which the reinforcement normal to areas of the main stresses gets under the action of tension stresses of any kind and arbitrary orientation, thus making possible prevention of a premature development of cracks in concrete and improvement of the resistance thereof to spalling, breaking and explosions.

2. A method of strengthening reinforced concrete structures incorporating the application of reinforcement elements and concreting in forms, **characterized** in that the sheet reinforcement with lugs in a free nonprestressed state is used as reinforcement elements which are placed in the form, the form is filled with a concrete mix which is cured until a complete bonding of the concrete mix with the sheet reinforcement and the lugs is attained, thus providing conditions for forming a frame of the reinforced concrete structure from the sheet reinforcement and for prevention of premature development of cracks in concrete as well as for improvement of the resistance thereof to spalling, breaking and explosions.

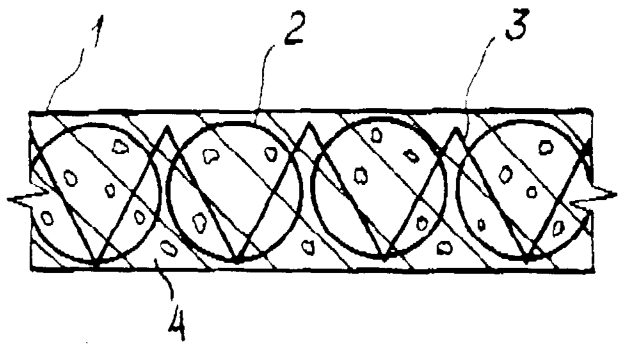

Fig. 1

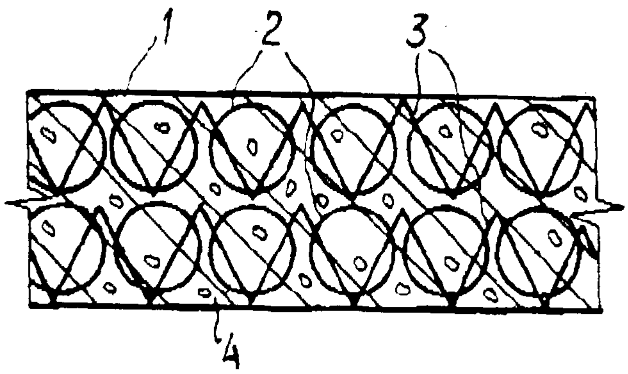

Fig. 2

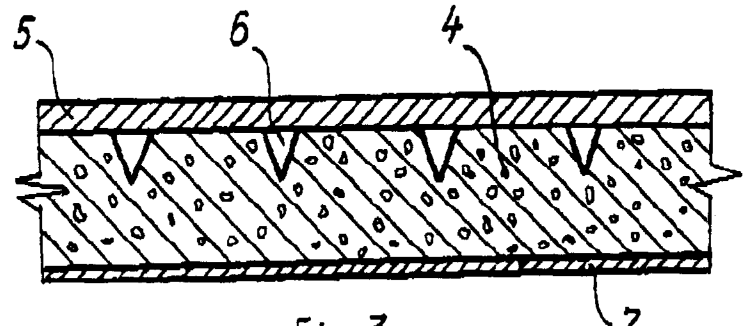

Fig.3

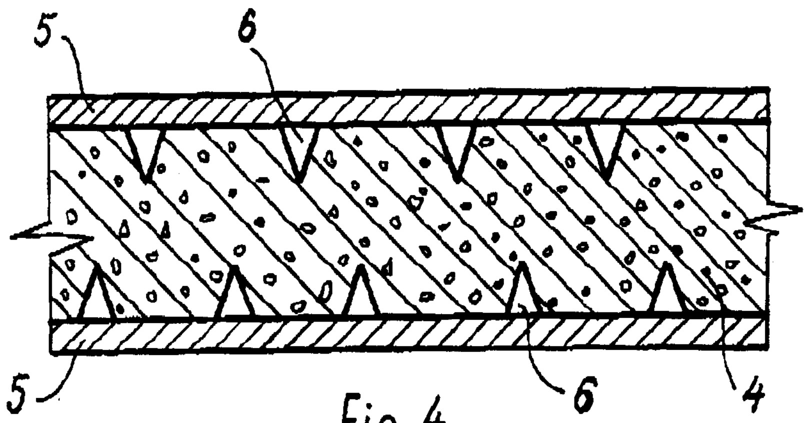

Fig. 4

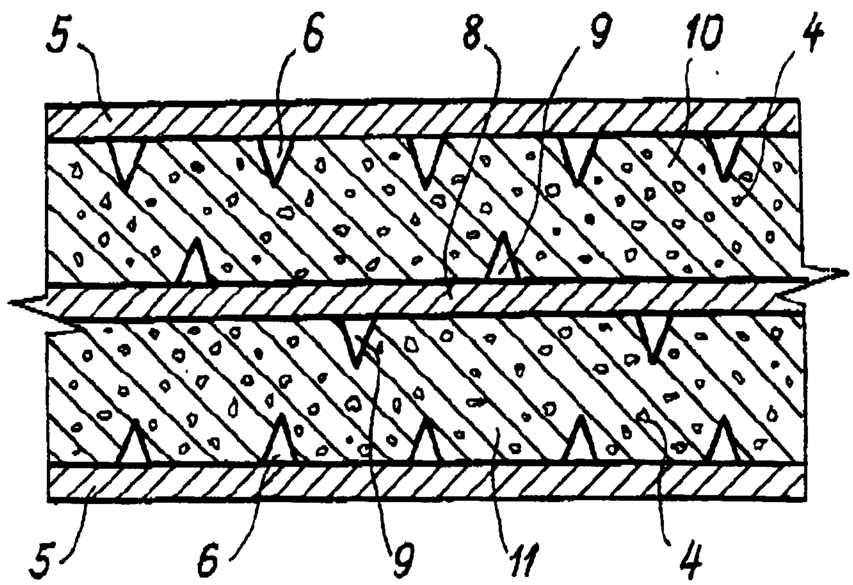

Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 96/00261

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.^{6} E04C 5/06, E04G 21/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl.^{6} E04C 5/00, 5/03-5/065, E04H 9/00, E04B 1/16, E04G 21/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SU, A 137657 (A.K. SHANSHIEV), 15 July 1961 (15.07.61)	1
A	SU, A, 1044749 (URALSKY ELEKTROMEKHANICHESKY INSTITUT INZHENEROV ZHELEZNODOROZHNOGO TRANSPORTA), 30 September 1983 (30.09.83)	1, 2
A	SU, A1, 1760045 (TSENTRALNY NAUCHNO-ISSLEDOVATELSKY I PROEKTNY INSTITUT STROITELNYKH METALLOKONSTRUKTSY im. N.P. MELNIKOVA et al),7 September 1992 (07.09.92)	2
A	US, A, 3496691 (BETHLEHEM STEEL CORPORATION), 24 February 1970 (24.02.70)	2
A	CH, A5, 632551 (MATTI PEKKA HOME) 15 October 1982 (15.10.82)	2

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"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 when the document is taken alone
"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

Date of the actual completion of the international search	Date of mailing of the international search report
18 November 1996 (18.11.96)	24 December 1996 (24.12.96)
Name and mailing address of the ISA/ RU	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)