(57) Abstract: A fixed construction (10) comprises an under layer (12) and an upper layer (14) which is poured upon the under layer (12). The under layer (12) is a floor (to be renovated) of concrete or of asphalt. The upper layer (14) is a renovation layer. The upper layer (14) comprises high-performance concrete (pressure strength > 80 MPa) which is reinforced by a combination of fibers (22) and of steel rods (24) with a yield strength higher than 650 MPa.
— Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.

For two-letter codes and other abbreviations, refer to the “Guidance Notes on Codes and Abbreviations” appearing at the beginning of each regular issue of the PCT Gazette.
RENOVATION LAYER WITH A COMBINATION REINFORCEMENT

Field of the invention.
The present invention relates to a fixed construction which comprises an under layer and an upper layer poured on the upper layer. The upper layer functions as a renovation layer.

Background of the invention.
Existing industrial floors of concrete or asphalt which need to be replaced or renovated, e.g. because of too many cracks in the floors, present a major technical and economical problem.

Replacing the existing floors by first breaking the floors out is time consuming and expensive, particularly since the process of breaking out must not cause any damage to existing structural parts such as columns, walls and gates. In case the existing floors had been reinforced, this process is even more time consuming and expensive.

Pouring an upper layer of concrete above the existing floor very often does not present a solution to the above problem. The outer layer must withstand both longitudinal tensions and transversal tensions, which means that it must have a thickness which is substantially greater than 120 mm. In a lot of circumstances this thickness is not acceptable, having regard to existing gates and passages.

Trying to reduce this thickness to acceptable dimensions by increasing the amount of reinforcement in the upper layer, leads to too high a concentration of the reinforcement. In case the reinforcement is a conventional steel rod reinforcement, the high amount of steel rods is detrimental to the adhesion with the concrete. In case the reinforcement is done by means of steel fibers, the high amount of steel fibers in concrete leads to mixing problems and to steel fibers which are not homogeneously distributed in the concrete.
Summary of the invention.

It is an object of the present invention to provide for a renovation of existing industrial floors which saves time and costs.

It is another object of the present invention to provide for a renovation of existing industrial floors which limits the required thickness of the upper layer.

It is yet another object of the present invention to enable renovation of existing industrial floors in a flexible way.

According to the invention there is provided a fixed construction which comprises an under layer and an upper layer poured on the under layer. The under layer is an existing floor of concrete or asphalt (which is to be renovated).

The upper layer is a renovation layer, preferably of the jointless type.

The upper layer comprises high-performance concrete which is reinforced by a combination of:
- fibers; and of
- steel rods with a yield strength higher than 650 MPa, e.g. higher than 700 MPa.

The terms 'high-performance concrete or mortar' refer to concrete or mortar the compression strength of which is higher than 80 MPa (1 MPa = 1 Mega-Pascal = 1 Newton/mm²), e.g. higher than 100 MPa, or higher than 150 MPa or even higher than 200 MPa. The compression strength is the strength as measured by ASTM-Standard N° C39-80 on a cube of concrete of 150 mm edge, where the cube is pressed between two parallel surfaces until rupture.

In comparison with conventional concretes, high-performance concretes are characterized by:

(a) a relatively low water/cement ratio (smaller than 0.45);
(b) the addition of superplasticizers which much increase the workability of concrete in spite of the low water/cement ratio;
(c) the addition of mineral additives such as silica fumes, fly ashes, blast furnace slag, pulverized fuel, micro-fillers and/or pozzolans and/or the addition of chemical additives such as water glass and tensides.

A high-performance concrete is suitable since, having regard to its increased degree of workability, it is able to fill the cracks and joints present in the existing under layer.

The fibers provide a homogeneous reinforcement in the upper layer and increase the resistance of the upper layer against transverse tensions.

The steel rods provide for an additional and flexible reinforcement. The amount of cross-section of steel rods and the distance between two successive steel rods may vary and depends upon the load on the upper layer (the higher the load the higher the amount of cross-section of steel rods and the smaller the distance between two steel rods), upon the thickness of the upper layer and upon the ratio length to width of the upper layer.

The high yield strength of the steel rods either reduces the total amount of reinforcement (= fibers + rods) required or reduces the thickness of the upper layer.

Without the presence of the fibers, too much cross-section of steel rods would be required.

Without the presence of the steel rods, too high a concentration of fibers would be required.

In a preferable embodiment of the invention, the high-performance concrete is a self-levelling concrete. A self-levelling concrete is a high-performance concrete where the maximum level difference over a distance of two meter is lower than or equal to 4 mm, preferably lower than or equal to 3 or even 2 mm.

In a self-levelling concrete the amount and type of plasticizers or superplasticizers, and the amount and type of viscosity agents is so
chosen that the concrete is as fluid as possible without causing segregation of the coarse material such as stones or fibers present in the self-levelling concrete.

In another preferable embodiment of the invention, the steel rods are arranged in pairs. The rods of each pair are transversely connected with each other by means of a transverse element. These transverse steel elements are conveniently made of a softer steel, i.e., a steel with a carbon content which is lower than the carbon content of the steel rods. This allows to make perfect welded joints between the transverse steel elements and the steel rods. In this way the combination longitudinal rods - transverse steel element forms a "bi-steel strip". The transverse steel elements may be round in cross-section or flat. In the latter case, the flat face forms a right angle with the longitudinal axis of the rods. The flat face prevents a transmission of oblique forces to the concrete.

In the context of the present invention the diameter of the steel rods of a bi-steel strip may vary from 3 mm to 12 mm, preferably from 3 mm to 10 mm.

The presence of the transverse steel elements helps to improve the anchorage in the concrete. The distance between two parallel rods in each pair is about the same order of magnitude as their diameter. The interval between the transverse steel elements is usually higher than the distance between the longitudinal rods but does not exceed 200 mm. A typical value is 95 mm. Preferably the pair of rods are placed and supported by means of spacers which can be made of a synthetic material.

Due to the combined applying of:
- a high-performance concrete;
- fibers; and
- high-tensile steel rods,
the thickness of the upper layer can be kept within acceptable limits, e.g.
the thickness varies from 40 mm to 120 mm.

The fibers are preferably steel fibers, and preferably high-tensile steel
fibers with a tensile strength above 2000 MPa. These high-tensile steel
fibers have a carbon content above 0.40 %, e.g. above 0.75 %, or above
0.82 %. The high degree of tensile strength further reduces the total
amount of steel reinforcement required in the concrete.

These steel fibers may be provided or not with anchorages to increase
the mechanical bond with the high-performance concrete.
The concentration of these steel fibers conveniently ranges from 20
kg/m³ to 50 kg/m³.

In case the fixed construction of the invention has a rectangular surface
with a length L and a width W, steel rods will run both in a direction of the
length and in a direction of the width. The cross-section of the steel rods
running in the direction of the length is preferably greater than the cross-
section of the steel rods running in the direction of the width, since the
tensions to be taken up in the direction of the length are much greater
than the tensions to be taken up in the direction of the width.

**Brief description of the drawings.**

The invention will now be described into more detail with reference to the
accompanying drawings wherein
- FIGURE 1 gives a cross-section of a fixed construction according to
the invention;
- FIGURE 2 gives a schematical view of another fixed construction
according to the invention;
- FIGURE 3 is a perspective view of a bi-steel strip;
- FIGURE 4 shows how bi-steel strips can be supported by means of a spacer.

Description of the preferred embodiments of the invention.

FIGURE 1 gives a cross-section of a fixed construction 10. Fixed construction 10 comprises an under layer 12 which is a floor of concrete or of asphalt to be renovated. The fixed construction 10 further comprises an upper layer 14 which is poured upon the under layer 12 and which constitutes the renovation layer. The under layer 12 rests on a compacted subbase 16 or directly on the naturally occurring ground 16.

The under layer 12 may exhibit joints such as a control joint 18 or a construction joint or other joints, and very often has cracks 20, which are mainly the reason for the renovation. The upper layer 14 is composed of high-performance concrete, preferably of self-levelling concrete, which is reinforced by means of steel fibers 22 and by means of bi-steel strips 24. The steel fibers are homogeneously distributed in the upper layer 14 and form a constant and uniform reinforcement over the whole upper layer.

The bi-steel strips 24 have the advantage that they can be positioned at places where additional reinforcement is required. Referring to FIGURE 1, for example, a bi-steel strip 24 can be positioned at the level of a control joint 18 and/or at the level of a crack 20, since in such a region greater transversal forces need to be taken up.

Another example of the flexibility of the additional reinforcement by the steel rods or by the bi-steel strips, is that they can be concentrated in the zones around columns or around other fixed parts which are anchored in the under layer 12.

FIGURE 2 is a schematical view of another fixed construction 10 with a length L and a width W, where the length L is greater than the width W.
As a consequence, the tensions, more particularly the tensions caused by concrete shrinkage, to be taken up in a lengthwise direction are greater than the tensions to be taken up in a widthwise direction. This difference in amount of tensions can be taken into account by positioning more steel rod reinforcement 24' in lengthwise direction than steel rod reinforcement 24" in widthwise direction, e.g. by smaller distances between bi-steel strips 24' than between bi-steel strips 24".

For reason of completeness, FIGURE 3 and FIGURE 4 disclose a bi-steel strip 24.

FIGURE 3 gives a perspective view of a bi-steel strip 24 made from two parallel wire rods 26. The parallel wire rods 26 are connected by means of transverse flat steel elements 28 which are welded to the wire rods 26.

FIGURE 4 illustrates how steel rods 26 and 26' are easily placed in a flexible way and supported by means of a spacer 30 which can be made of a synthetic material.

**Example**

- thickness of the upper layer = 50 mm
- pressure strength of the high-performance concrete = 100 MPa
- tensile strength of the high-performance concrete = 3.5 MPa
- the maximum force which can be taken up by the non-cracked concrete is
  
  \[ \text{3.5 N/mm}^2 \times \text{1000 mm} \times \text{50 mm} = \text{175,000 Newton} \]

- suppose that the steel fibers (30 kg/m³) take up 50 % of the forces after cracking, this is \( \text{175,000 Newton} / 2 = 87,500 \) Newton

- 87.500 Newton still needs to be taken up by the bi-steel strips
- if the tensile strength of a bi-steel strip is 700 MPa,
then 87.500 Newton / 700 Newton/mm² = 125 mm² steel cross-
section is needed per meter
- suppose a 6 mm diameter steel rod is used, then

\[
125 \times \frac{4}{\pi \times 6 \times 6} = 4.42
\]
steel rods are required per meter,
which means that 3 bi-steel strips per meter are sufficient.
- CLAIMS 

1. A fixed construction comprising an under layer and an upper layer poured upon the under layer, 
   said under layer being a floor (to be renovated) of concrete or asphalt, 
   said upper layer being a renovation layer, 
   characterized in that said upper layer comprises high-performance concrete (pressure strength > 80 MPa) which is reinforced by a combination of fibers and of steel rods with a yield strength higher than 650 MPa. 

2. A fixed construction according to claim 1 wherein said high-performance concrete is a self-leveling concrete. 

3. A fixed construction according to claim 1 wherein said steel rods are arranged in pairs and wherein the rods of each pair are transversely connected with each other by means of a transverse steel element. 

4. A fixed construction according to claim 3 wherein the diameter of said rods ranges from 3 mm to 10 mm. 

5. A fixed construction according to any one of the preceding claims wherein said upper layer has a thickness ranging from 40 mm to 120 mm. 

6. A fixed construction according to any one of the preceding claims wherein said fibers are steel fibers. 

7. A fixed construction according to claim 6 wherein said steel fibers have a tensile strength greater than 2000 MPa.
8. A fixed construction according to claim 6 or claim 7 wherein said fibers are present in said upper layer in amounts ranging from 20 kg/m³ to 50 kg/m³.

9. A fixed construction according to any one of the preceding claims, said fixed construction having a length and a width, said steel rods running both in a direction of the length and in a direction of the width, said steel rods running in the direction of the length having a cross-section which is greater than the cross-section of said steel rods running in the direction of the width.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

| IPC | E04F 15/12 | E04G 23/02 |

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)

| IPC | E04F | E04G | E04C |

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 practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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Name and mailing address of the ISA:
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