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DECK SYSTEM

The invention concerns a deck element for use in constructing floors and decks by laying one or more such elements between beams and covering it or them
5 with concrete, to floors made using such profiles, and to a method of constructing such a floor.

Buildings such as offices are often constructed nowadays by so-called "fast track" techniques. In these methods flat metal deck sections, usually
10 corrugated, are first placed or supported on the top flanges of beams or girders for the floor in question so as to cover the area between the beams. Concrete is then poured over the covering thus formed and allowed to set, the metal sections remaining in situ. This
15 method has the advantage of a rapid speed of construction generally costing no more, and possibly less, than conventional techniques.

In another known system metal decking is formed by approximately square sections the length of a side of
20 which matches the distance between adjacent beams. The square sections rest on the lower flanges of the beams and may form the ceiling for the floor below. Most of the area of the square is taken up by a spherically upwardly convex dome shape serving to reinforce the
25 section against the weight of the concrete to be applied on top of it. The square elements are laid horizontally adjacent one another in a line along the longitudinal space between each pair of adjacent beams, opposite side edges resting for instance on the bottom
30 flange of respective I-beams, to fill the area required; the elements may be interlocked with each other at their adjacent edges.

However, such known methods have disadvantages, as follows. First, the resistance of such constructions
35 to heat may not meet fire safety standards and additional fire protection may have to be applied.

This increases the expense of the system, reducing its economic attractiveness. Secondly, the span between adjacent beams which can be covered by such systems is limited; in the case of the dome system the span might
5 be only 60 cm, because whilst the upwardly presented dome shapes are strong in themselves to support downwardly applied loads, the remaining flat parts of the square sections are weaker. In fast track systems the maximum span is about 3m. Thirdly, although the
10 square sections in the dome system are left in place in the final construction the strength of the system is not generally adequate without further measures, and so the concrete usually needs to be reinforced, for instance by reinforcing bars arranged transverse to the
15 beams and passing through them.

It is an object of the invention to solve, or at least mitigate, the above problems.

According to one aspect of the invention there is provided a decking system comprising at least two
20 generally parallel beams and a deck element supported between each pair of beams, the element having opposite edge regions and between these edge regions continuous decking adapted to span the space between the beams, the element being of a generally upwardly arched shape
25 between the opposite edge regions with the axis of the arch being generally parallel to the edge regions, and the upper surface of the arch element varying in depth along the axial direction of the arch, on a scale small compared with the span of the arch, so as to stiffen
30 the arch, wherein each beam has a bottom flange or intermediate support on which the corresponding side of the element is supported, and a layer of concrete is applied over the deck element so as to envelop at least the upper part of each beam.

35 Advantageously the depth variation arises from the fact that the longitudinal cross-section of the

element, at least in the central area of the arch, has a corrugated form.

The variation, in particular the corrugation, is, for ease of manufacture and consistency, preferably
5 regular and uniform across the span from one edge to the other, its pitch being considerably smaller than the beam spacing.

The arched form of the elements brings about a considerable increase in strength by comparison with
10 known flat elements or dome shuttering. This increase in strength means that greater spans between beams can be covered by systems embodying the invention - possibly 4.5m to 7.5m - without unduly large depth-to-span ratios; with the known systems heavy-gauge
15 material would have to be used to support the wet concrete, which would be expensive and difficult to form. Since systems in accordance with the invention require no further reinforcement - although such may of course be provided if desired - standard-section beams
20 can be used.

Conceivably the depth variation could be achieved by other features of the arch shape than corrugation. For instance, a plain arch could have arch ribs welded on to its upper surface at intervals along its length,
25 or indentations spaced both axially and in the curved direction.

The corrugation of the elements, as well as stiffening the arch, has the further advantage of affording an increased surface area for bonding with
30 concrete. Hence when concrete is applied a mechanical keying or anchorage between the sheet elements and the concrete, considerably increasing the final strength and fire resistance of the structure, whereas the prior art dome elements function essentially merely as
35 shuttering, so that additional reinforcement is required. The strength can be further increased by

providing re-entrant, e.g. dovetail corrugations for full composite action.

The elements may be made of steel sheet, glass reinforced plastics or glass-reinforced cement. The deck
5 elements and beams can be either composite or non-composite with the concrete; in general steel elements will bond with concrete to give an at least partly composite structural member. The elements can be
10 manufactured as continuous 'tunnel'-shaped elongate sections or assembled from two or more axially aligned curved sections. In the latter case restraint or dovetail cross-section profiles would facilitate site or shop assembly.

Each element preferably rests on the bottom flange
15 of the beams, if present, or from a suitable intermediate support on the web of the beam. In either case the elements may be simply placed on the flange or intermediate support or may be fastened to it, by welding for instance.

20 If the arch elements rested on top of the beams as in the fast track system mentioned above this would significantly increase the depth of the structure and would leave the beams exposed and thus afford no fire protection. Hence the beams are at least partially
25 buried in the concrete when this is poured, which gives built-in fire resistance. Tests have shown that the fire resistance of this composite structure is then satisfactory without the need for additional measures.

An embodiment of the invention will now be
30 described with reference to the accompanying drawings, in which:

Figs. 1 to 4 show cross-sections of different embodiments of arch systems according to the invention;
Fig. 5 is an elevational view showing beam



spacings;

Fig. 6 is a schematic longitudinal cross-sectional detail of part of an arch element with concrete applied, and

5 Fig. 7 is a partial perspective view of an arch section resting on an I-beam.

Figs. 1 to 4 all show arch systems supported on I-beams so that at least the top part of each beam is embedded in concrete, thus ensuring effective fire
10 protection. In Figs. 1 to 3 the arch elements 2 all rest on the bottom flange 4 of the beams 1, while in Fig. 4 they are shallower and rest on intermediate supports (not shown) on the web of the beam.

In Figs. 1 and 2 the arches have a small radius of
15 curvature near the point of support, so that their section rises steeply from the flange 4 and then levels off fairly rapidly, continuing at a shallow inclination towards the middle. In Fig. 1 the two sides of the arch meet in a vertex, while in the Fig. 2 embodiment
20 the arch has a gradual curve from one side to the other in the central section.

In Figs. 3 and 4 the arch has a roughly constant curvature, which may for instance be circular, elliptical or parabolic, over the entire beam spacing.

25 Fig. 5 shows typical dimensions for spans and lengths of the arch element sections used in embodiments of the invention.

In the sectional close-up of Fig. 6, taken in the longitudinal direction near the top of an arch and
30 showing the concrete layer 3, the corrugations in the arch profile 2 can be seen. Typically the pitch of these might be 15-30 cm and their height 5-6 cm. Although in this embodiment the corrugations are trapezoidal, other configurations could of course be
35 used, such as triangular, wave-like or dovetail. Fig. 6 also shows an additional mesh reinforcement 5 in the

concrete, although for many purposes the composite action produced by the mechanical bond over the extended surface area between the concrete and the corrugated profile would be sufficient.

5 Fig. 7 shows an embodiment with regular, transversely uniform corrugation in the arch profile 2. As can be seen, the pitch of the corrugations is considerably smaller than the beam spacing, while the radius of curvature of the arch shape is considerably
10 larger than the beam spacing and might typically be 10-20m.

It can also be seen in Fig. 7 that the longitudinal edge of the arch 2 is supported vertically by the flange 4 and horizontally by the web of the beam
15 1, resulting in a very stable configuration.

During construction the corrugated arch elements are laid on the lower flanges of the beams as shown in Fig. 7. Ties, possibly permanent but generally of a temporary nature, are then fastened or clipped to the
20 lower flanges on end spans of the beam members to ensure that the arch does not spread when the concrete is poured. The pouring of the concrete then takes place, covering the arch elements and the beams, providing both excellent fire protection due to the
25 embedding of the beams in the concrete and strength due to the composite action between the arch elements and the concrete.

The arch profiles themselves may be formed by rolling on a differential roll using traditional plate-making techniques or alternatively, and most simply,
30 crimped at the corrugations to form one or more kinks, giving the arches a generally polygonal arch cross-section composed of a series of straight segments. Arches have been made having fourteen crimps over a 6m
35 span; these have the appearance of a smooth arc section and have performed adequately in tests.

One of the advantages of the invention over the dome system mentioned earlier is that the arch profiles can be provided in any length, and if desired cut to size on site. It is nevertheless also possible in a
5 method according to the invention to provide two or more arch profiles along the space between the beams.



CLAIMS:

1. A decking system comprising at least two generally parallel beams and a deck element supported between each pair of beams, the element having opposite
5 edge regions and between these edge regions continuous decking adapted to span the space between the beams, the element being of a generally upwardly arched shape between the opposite edge regions with the axis of the arch being generally parallel to the edge regions, and
10 the upper surface of the arch element varying in depth along the axial direction of the arch, on a scale small compared with the span of the arch, so as to stiffen the arch, wherein each beam has a bottom flange or intermediate support on which the corresponding side of
15 the element is supported, and a layer of concrete is applied over the deck element so as to envelop at least the upper part of each beam.
 2. A decking system according to claim 1, wherein the longitudinal cross-section of the element, at least in
20 the central area of the arch, has a corrugated form, constituting the said depth variation.
 3. A decking system according to claim 2, wherein the corrugations have a dovetail form.
 4. A decking system according to claim 1, 2 or 3,
25 wherein the depth variation in the element is regular and uniform across the span from one edge to the other, its pitch being considerably smaller than the beam spacing.
 5. A decking system according to any preceding claim,
30 wherein the span of the arch of the element is approximately 4.5 - 7.5m.
 6. A decking system according to any preceding claim, wherein the elements are made of steel, glass-reinforced plastics or glass-reinforced cement.
 - 35 7. A decking system substantially as described herein with reference to the accompanying drawings.
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