

Security Barrier Structure

The present invention relates to barrier structures for use eg in the walls and/or doors of safes, strongrooms and the like security enclosures. Barrier structures provided for this purpose must have a high degree of resistance to penetration by a variety of mechanical and thermal tools, and as the forms of tool which may be appropriated for attacks on such enclosures are developed so also must the barrier structures for resisting them be improved. In this regard the present invention is particularly concerned to provide a security barrier structure with high resistance to penetration by a certain class of industrially-useful cutting tool, namely diamond drills, saws and similar diamond-tipped tools.

The diamond drill is a form of core drill (holesaw) which typically comprises a steel tube having welded to one end thereof a series of "teeth", the teeth comprising particles of diamond embedded in a softer matrix material. These drills are intended for cutting hard minerals, concrete and the like materials and depend for their operation on the continual wearing down of the matrix material in the drill tip by the work being cut, so as continually to expose fresh diamond particles. Similar cutting teeth can be provided on the circumference of a circular saw for example.

The present invention resides in a security barrier structure comprising a substrate layer onto which is cast a layer of security material; anchor means extending from the substrate layer into the mass of the cast layer; and at least one reinforcing member attached to the anchor means so as to be embedded within the mass of the cast layer; the or each said reinforcing member comprising a tube generally aligned with the plane of the barrier and containing a plurality of loose elements having freedom to perform movement within the tube with components of both rotation and translation in response to contact with a rotary tool, and arranged so that a cross-sectional plane taken at substantially any position along the length of the tube intersects at least two ^{separate} ~~different~~ such elements.

The elements which are contained within the tube of a said reinforcing member may for example comprise a plurality of rods of a relatively hard metal (eg tensile steel), ceramic (eg aluminium oxide) or other hard material arranged generally parallel to one another and to the axis of the tube. Such elements may act to resist penetration of the barrier structure by a diamond drill, in the following way.

Thus, assuming that the drill has penetrated the part of the surrounding security material between the exterior of the enclosure and the reinforcing member and has also cut through part of the wall of the tube of the reinforcing member, the ensuing contact of the contained elements with the rotating drill tip will in general cause those elements also to rotate, thereby significantly slowing the rate at which individual elements can be cut or preventing them from being cut at all. Moreover since the elements are loosely packed they can also revolve or otherwise move about translationally inside the tube and thereby set up strong vibrations in the drill leading to rapid wear of the drill tip and fracture of its

teeth and other possible damage to the drilling machine. The
alternative inclusion of a multiplicity of relatively small hard elements
of a size to fit between the teeth of the drill tip is also
of advantage, such elements tending to snap off the drill
5 teeth as the tool continues to rotate with the hard elements
trapped between its teeth.

However, the inclusion of softer and more malleable elements
in the tube of a said reinforcing member, such as mild steel
10 rods or the like, has also been found to frustrate attempts
to penetrate the reinforcing member with a diamond drill,
although in this case the mechanics are somewhat different.
In this case when the wall of the tube is penetrated the soft
elements, suitably sized for the purpose, can get between the
15 drill teeth and between the drill and the walls of the core
which the drill has prepared in the surrounding security
material, and thereby act to jam the rotation of the tool.
Furthermore these softer elements tend not to wear the matrix
material of the drill teeth rapidly enough to expose
20 sufficient diamond particles to cut the elements; instead the
rubbing action of the rotating drill on the elements
generates excessive heat and if mild steel elements are used,
for example, they may become welded to the tool and thus
still further reduce its efficacy. If the tool is withdrawn
25 under these conditions the molten metal may become spread
over the walls of the drilled core and thereby prevent
reinsertion of the tool to the same depth as it has
previously drilled.

30 In some embodiments a mixture of the harder and softer
elements referred to above may also be of advantage.

The layer of security material, so-called herein, within
which the aforesaid reinforcing members are embedded may in
35 general be provided by any one of the known castable

penetration-resistant materials customarily used in the construction of security enclosures, thus including selected concrete, metal and elastomer materials, with or without additional penetration-resistant constituents. However it is
5 within concrete security barriers that the inclusion of these reinforcing members is likely to be of the greatest benefit, and a particularly preferred security material which, when used together with such members in a barrier structure according to the invention can provide balanced resistance to
10 a wide variety of forms of mechanical and thermal attack at reasonable cost, is steel fibre-reinforced concrete.

Examples of barrier structures according to the invention will now be described with reference to the accompanying
15 diagrammatic drawings, in which:

Figure 1 is a horizontal section taken through the wall of a safe or the like enclosure and illustrating the general form of barrier structure;

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Figures 2a and 2b are respectively vertical and horizontal sections, to an enlarged scale, taken through a first embodiment of reinforcing member for use in the structure of Figure 1; and

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Figures 3a and 3b are views similar to Figures 2a and 2b of a second embodiment of reinforcing member.

Referring to Figure 1, there is shown a mild steel backing plate 1 (which defines the inside surface of the enclosure) to which is secured a layer of steel fibre-reinforced
30 concrete 2 with embedded therein a series of elongate

reinforcing members 3. Rows of steel anchors 4 are welded to the back plate 1 to extend into the mass of the concrete layer 2, and the reinforcing members 3 are welded to the anchors 4 so as to lie generally in the plane of the barrier structure and transverse to any expected line of attack thereon. The primary purpose of the members 3 is to increase the resistance of the structure to penetration by a diamond core drill, although they may of course similarly act to resist penetration by other types of rotary tool.

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Figures 2a and 2b show one form of reinforcing member 3 which can be used in the structure of Figure 1. It comprises a tube 5, typically of mild steel, capped at each end 6 and containing a small number of loosely-packed parallel rods 7, each extending through the full length of the tube. The rods 7 are typically made of tensile steel. Three such rods are shown in the Figures, each having a typical diameter of 7mm, with the inside diameter of the tube 5 being about 20mm. There is thus sufficient space within the tube 5 for the rods 7 not only to rotate around their own respective axes but also to move about independently in the lateral sense. When such a reinforcement is encountered by the tip of a diamond drill cutting through the tube wall 5, the rods will accordingly rotate and vibrate under the action of the drill tip to slow or prevent the drill from cutting the rods, and to spoil the tool.

Turning to Figures 3a and 3b these show a form of reinforcement 3 in which the tube 5 is packed throughout with a multiplicity of randomly-orientated rods or needles 9 of a relatively soft and malleable metal - eg mild steel of a grade from which ordinary wood-fixing nails are customarily made. These rods typically have a diameter of 1-1.5mm and a length which is slightly less than the internal diameter of the tube 5, eg 15-18mm in a 20mm tube. The rods 9 are

therefore of a size such that they can adopt any orientation within the tube 5 and are small enough to be able to pass out of the tube when the latter is penetrated by a diamond drill tip. Elements of this type frustrate the action of the drill in a somewhat different manner to the harder elements 7 and 8 of the Figures 2^a and 2^b embodiments, as previously described. That is to say they tend to jam the rotation of the tool by getting between the drill teeth and between the drill and the walls of the core which it has prepared in the concrete layer 2, and can even become welded to the drill and core.

In another embodiment of a reinforcing member 3 the tube 5 is filled with elements of a similar form to the mild steel rods 9 of Figure 3³, but in this case the rods are of hard steel eg of a grade from which masonry nails are made. These can act to frustrate the drill by snapping off its teeth when the rods are caught between the rotating teeth, in addition to rotation and vibrating within the tube.

A mixture of mild steel and hard steel rods 9 within the same tube 5 is also possible in order to give a combined resistive effect to the drill. In this case a ratio of approximately 2:1 in the numbers of the softer and harder elements has been found to be particularly efficacious.

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Returning to Figure 1, to produce a structure of the type shown the rows of anchors 4 are first welded to the back plate 1 and the tubes 5 of the prepared reinforcing members 3 are then welded to the anchors 4. After fabricating this assembly the plate 1 is assembled with a re-usable mould structure (not shown) to define an appropriate cavity for the layer 2, and the wet concrete mixture with dispersed steel fibres is poured in. When the concrete 2 has set the plate 1 and mould structure are separated to leave the barrier structure as shown in Figure 1.

The concrete thickness is typically 150mm with the reinforcing members 3 at a typical depth of 105mm from the external concrete surface and pitched at no more than 75mm apart so that any core drill which is adapted to form a "handhole" size aperture will encounter at least one of the members 3 before the barrier structure is penetrated. Advantageously the spacing between adjacent pairs of reinforcing members 3 is irregular (within a maximum specified dimension as typified above) to increase the difficulty of predicting the reinforcement positions from the outside.

In addition to performing the function of resisting the diamond drill or other rotary tools as indicated above, the reinforcing members 3 serve together with the anchors 4 to maintain the integrity of the concrete layer 2 and to offer high resistance to separation of the concrete from the backing plate 1. Furthermore, the use of steel fibre reinforcement in the concrete of the layer 2 imparts high tensile strength to the concrete, so that if a diamond drill is used to penetrate the concrete up to a reinforcing member 3 it will be difficult to detach the partially-drilled core from the remainder of the concrete layer in order to gain access to the member 3 with different tools to which it may be more vulnerable. This difficulty is compounded by providing the reinforcements 3 at a considerable depth within the layer 2. Moreover, by associating the reinforcements 3 with the anchors 4 (which extend to within, say, 35mm of the outer surface of the layer 2), it is likely that any partially-drilled core which reaches a member 3 will encompass the outer end of an anchor 4 and thus the core will be retained in place by this means also.



CLAIMS

1. A security barrier structure comprising a substrate
layer onto which is cast a layer of security material;
5 anchor means extending from the substrate layer into
the mass of the cast layer; and at least one reinforcing
member attached to the anchor means so as to be embedded
within the mass of the cast layer; the or each said
reinforcing member comprising a tube generally aligned
10 with the plane of the barrier and containing a plurality
of elements having freedom to perform movement within
the tube with components of both rotation and
translation in response to contact with a rotary tool,
and arranged so that a cross-sectional plane taken at
15 substantially any position along the length of said tube
intersects at least two ^{separate} ~~different~~ such elements.
2. A barrier structure according to claim 1 wherein a said
reinforcing member comprises a tube containing a
20 plurality of rods of hard material arranged generally
parallel to one another and to the axis of the tube.
3. A barrier structure according to claim 1 wherein a said
reinforcing member comprises a tube containing a
25 multiplicity of small elements of malleable material.
4. A barrier structure according to claim 1 wherein a said
reinforcing member comprises a tube containing a
multiplicity of small elements of hard material.



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5. A barrier structure according to claim 1 wherein a said reinforcing member comprises a tube containing a multiplicity of small elements some of which are of malleable material and others of which are of hard material.
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6. A barrier structure according to any one of claims 3 to 5 wherein said small elements are in the form of rods of a length which is less than the internal cross-sectional dimension of said tube.
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7. A barrier structure according to any preceding claim wherein a said reinforcing member is embedded within the mass of said cast layer at such a depth within that layer that it is closer to said substrate layer than to the outer surface of the cast layer.
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8. A barrier structure according to any preceding claim wherein a said anchor means extends from said substrate layer into the mass of said cast layer to a position significantly beyond its position of attachment to a said reinforcing member.
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9. A barrier structure according to any preceding claim wherein said security material is steel fibre-reinforced concrete.
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10. A security barrier structure substantially as hereinbefore described with reference to the accompanying drawings.
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