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(71) Applicant (*for all designated States except US*): **EX-CHEM PLC** [GB/GB]; P.O. Box No 7, Venture Crescent, Alfreton, Derbyshire DE55 7RE (GB).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): **EWINGS, Paul, Francis, Reginald** [GB/GB]; 3 Bradgate Drive, Ripley, Derbys DE5 3JP (GB). **BROOKS, Dale** [GB/GB]; 380 Lower Somercotes, Somercotes, Derbys DE55 4NQ (GB). **HARVEY, Linda** [GB/GB]; 45 Larkhill, Swanwick, Derbys DE55 1DD (GB).

(74) Agent: **MURGITROYD & COMPANY**; Scotland House, 165-169 Scotland Street, Glasgow G5 8PL (GB).

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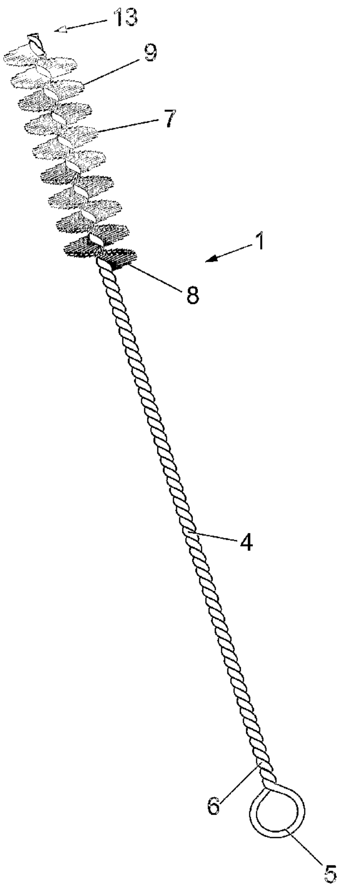
(54) Title: DUAL FIBRE BRUSHES



(57) Abstract: A drill hole cleaning brush (1) comprising a handle (2) and a brush head (3) on the handle (2) formed from filaments (8) wherein a first portion of the filaments (8) is formed from a high modulus material and a second portion is formed from a low modulus material.

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DUAL FIBRE BRUSHES

This invention relates to a cleaning brush for cleaning drilled holes in a substrate prior to injection of a resin bonding agent into the drilled hole to set an anchor in the substrate.

Resin bonded anchors can be categorised into three classes: bulk mixes, capsules and injection systems. In bulk mixes two or more resin components are measured out and mixed by an installer prior to application. Capsules can be either soft skin or glass type. Where capsules are employed, resin components are pre-measured and supplied within a frangible casing which is ruptured during the installation process. The reactive components are therefore released which facilitates mixing. In injection systems, two or more components are supplied pre-measured within a multi-chambered container and are then mixed by extrusion through a static mixer.

The performance of anchors with bulk mixes and injection systems is significantly influenced by the cleanliness or otherwise of the drilled hole. The drilling process, whether carried out wet or dry, generates dust. The dust can adhere to the wall of the hole and can act as a "slip layer", thereby inhibiting bonding and acting as a plane of weakness resulting in premature failure of the anchor. Accordingly, thorough cleaning of drilled holes is required to remove debris and facilitate an effective bond between the resin bonding agent and the substrate.

Capsule anchors are more tolerant of hole cleanliness as the installation process involves the rapid rotation of the anchor through the capsule whilst simultaneously applying pressure to push the distal end of the anchor towards the closed end of the drilled hole. The rotation and pushing action liberates the two or more components, mixes them together and in the process scours the wall of the drilled hole promoting an effective bond. This effect is particularly noticeable in the case of glass capsules where the glass fragments and aggregate create an efficient scouring and cleaning medium.

Hole cleaning is normally carried out using a combination of brushing and blowing or vacuum extraction. The brushing action dislodges the dust particles, which are then removed from the drilled hole by the forced airflow.

The brushes employed in the cleaning operations of the prior art are traditionally cylindrical in form and are manufactured using filaments bound and held by an elongate twisted wire. The elongate twisted wire is of sufficient length also to define a handle by which the brush is usually held in use. The handle can be provided with an opening to receive a transverse grip to aid use of the brush This type of brush is generically referred to as a "bottle brush" or "tube brush". The filaments can be man made, for example polypropylene (PPL), polybutylene terephthalate (PBT) or polyamide (PA); natural, such as bristle or horsehair and metal, for example steel or bronze. The twisted wire is usually galvanised steel, or stainless steel, dependent upon the application.

Known cleaning brushes suffer from a number of disadvantages. Man made filaments are less effective at hole cleaning while natural bristle brushes show improved performance over the man made filaments. However, man made filament brushes exhibit better wear resistance than the natural bristle brushes. Metal such as steel on the other hand is a very effective dust remover. However, the high stiffness, (stiffness is determined by three factors - modulus (resistance to bending), filament diameter and filament length) of steel filaments can make steel brushes difficult to use in the field. Moreover, due to the high stiffness, steel filament brushes are diameter sensitive so that, in general, a steel brush peculiar to each diameter hole is required whereas a natural bristle brush can normally be used for two or more diameter holes.

According to the invention there is provided a drill hole cleaning brush comprising a handle and a brush head on the handle formed from filaments wherein a first portion of the filaments is formed from a high modulus material and a second portion is formed from a low modulus material.

Preferably, the brush head comprises laterally extending filaments which project from the handle. More preferably, the filaments are arranged in a helix about the handle. Most preferably, the first portion of high modulus material filament and the second portion of the low modulus material filaments are arranged in blocks within the helical brush head.

Suitably, the first portion of the high modulus material filaments is disposed at a leading edge of the brush head.

Advantageously, the high modulus material filaments comprise a metallic material. Suitably, the metallic material is selected from the group comprising steel, copper, brass and bronze. Preferably, the metallic material comprises steel.

The low modulus material can comprise a natural or man made fibre. Preferably the low modulus material comprises a natural bristle. More preferably, the natural bristle comprises a hog bristle.

Alternatively, the low modulus material can comprise a polymer. Suitably, the polymer is selected from the group comprising polyolefin, polybutylterephthalate, polyamide, and polyester.

Preferably, the polyolefin is a polyethylene or a polypropylene.

In one embodiment of the invention, the brush head comprises from 5 to 50% high modulus material filaments and from 95 to 50% low modulus material filaments. Preferably, the brush head comprises from 15 to 35% high modulus material filaments and from 85 to 65% low modulus material filaments.

The invention also extends to a method of cleaning a drill hole comprising cleaning the drill hole with a cleaning brush comprising a handle and a brush head on the handle formed from filaments wherein a first portion of the filaments is formed from a high modulus material and a second portion of the filaments is formed from a low modulus material.

The invention also extends to the use of a drill hole cleaning brush having a brush head formed from filaments in which a first portion of the filaments is formed from a high modulus material and a second portion of the filaments is formed form a low modulus material in the cleaning of a drill hole.

In a further embodiment, the invention also extends to an anchorage system for installing an anchor member in a drilled hole in a substrate comprising an adhesive for setting the anchor member in the drilled hole and a drill hole cleaning brush having a handle and a brush head on the handle formed from filaments wherein a first portion of the filaments is formed from a high modulus material and a second portion of the filaments is formed from a low modulus material.

Various embodiments of the invention will now be described, by way of example only, having regard to the accompanying drawings and examples in which:

Figure 1 is a perspective view of a cleaning brush of the prior art in which the filaments are formed from a single material such as natural bristle or metal such as steel;

Figure 2 is a perspective view of a cleaning brush in accordance with the invention in which the brush head is made up of a steel filament portion and a natural bristle portion;

Figure 3 is a graph showing the results of Example 1 namely a comparison of loads versus brush type for an M8 fully threaded metric rod in dry holes;

Figure 4 is a graph showing the results of Example 2 namely a comparison of loads versus brush type for an M10 fully threaded metric rod in dry holes;

Figure 5 is a graph showing the results of Example 4 namely a comparison of loads versus brush type for an M12 fully threaded metric rod in dry holes;

Figure 6 is a graph showing the results of Example 4 namely a comparison of loads versus brush type for an M12 fully threaded metric rod in wet holes;

Figure 7 is a combined graph showing the results of Example 4 for comparison purposes;

Figure 8 is a graph showing the results of Example 5 namely a comparison of loads versus brush type for an M16 fully threaded metric rod in dry holes;

Figure 9 is a graph showing the results of Example 6 namely a comparison of loads versus brush type for an M20 fully threaded rod in dry holes;

Figure 10 is a graph showing the combined graphs of Figures 3 to 9 for comparison purposes, and

Figure 11 is a graph showing the results of Example 7 namely a comparison of loads versus brush type for four different brush types.

Figure 1 shows a perspective view of a cleaning brush 1 in accordance with the prior art. The cleaning brush 1 of the prior art is adapted for use in cleaning drilled holes in substrates such as concrete, masonry, rock and the like prior to injection of a resin bonding agent into the hole. The cleaning brush 1 is of generally bottle-brush construction and is made up of an elongate handle 2 defined by a longitudinal axis 10 and a brush head 3. The handle 2 is formed from a double-stranded twisted wire 4 formed into an eye 5 at a gripping end of the handle 2 while the brush head 3 is located at a brushing end 7 of the cleaning brush 1.

An elongate grip, typically formed from wood can be inserted in the eye 5 to form an easy-grip T-shape with the handle 2.

The brush head 3 is formed from laterally extending brush filaments 8 gripped between the strands of twisted wire 4 to define a helical brush 9 on the elongate handle 2.

The laterally extending filaments 8 and the cleaning brush 1 of the prior art are typically formed from a single material such as hog bristle, man made filaments or metal such as steel.

Figure 2 is a perspective view of a cleaning brush 1 in accordance with the invention. The cleaning brush 1 of the invention is broadly similar to the cleaning brush of the prior art and like numerals indicate like parts. However, in the cleaning brush of the invention, the brush head 3 is a dual filament brush head i.e. the brush head 3 is formed from two filament types namely a distal filament block 11 with respect to the eye 5 or handle proper 2 and a proximal filament block 12 with respect to the eye 5 or the handle proper 5 within the helical brush 9.

The distal filament block 11 is smaller than the proximal filament block 12 but is contiguous with the proximal filament block 12. More particularly, the distal filament block 11 is made up of fewer rotations of the helical brush 9 than the proximal filament block 12. The distal filament block 11 is formed from a metal material which in the present embodiment is steel while the proximal filament block 12 is formed from a natural filament such as hog bristle.

The steel distal filament block 11 defines a brush head leading end 13 which is first inserted into a drilling hole for cleaning.

The relative sizes of the distal filament block 11 and the proximal filament block 12 can be modified in accordance with the dimensions of the drill holes to be cleaned. Similarly, the length of the filaments are also varied in accordance with the diameter of the drill holes to be cleaned. The overall size of the brush head 3 can also be varied in accordance with drill hole requirements.

Table 1 below provides the suggested dimensions for the features A, B, C, D, E, F, G, H, I, J of the cleaning brush shown in Figure 2. Three cleaning brush 1 sizes, small, medium and large can be used in hole diameters ranging from 10mm to 26mm and depths of from 80mm up to 210mm i.e. with an M8 anchor in which a hole diameter of 10mm and a depth of 80mm is required up to an M24 anchor in which a hole diameter of 26mm and depth of 210mm is required.

Table 1: Suggested Dimensions for three Cleaning Brushes of the Invention

	SMALL	**MEDIUM**	**LARGE**
A	302.07	303.73	306.72
B	228.0	229.0	225.0
C	74.07	74.73	81.72
D	60.02	54.60	57.56
E	13.87	20.13	24.16
F	14.20	20.15	28.37
G	6.78	10.12	14.03
H	12.94	20.48	28.48
I	6.58	10.15	14.12
J	3.75	5.06	5.12

In a preferred embodiment of the invention, the proximal filament block 12 is formed from 100% pure natural bristle. A suitable bristle is derived from hogs and known as Chunking bristle. The bristle has a "constant" diameter section and is referred to as "100% tops" whereby any taper in the bristle has been eliminated or reduced. The "constant" diameter of the bristle typically ranges from about 0.14mm to about 0.17mm.

The distal filament block 11 is formed from stainless steel grade 316 (A4 – 70) which is crimped and has an individual filament diameter of 0.15mm. The twisted wire 4 of the handle 2 is formed from a galvanised soft twisting wire which can have a 12 or 14 standard wire gauge diameter dependent upon the diameter of the brush head portion 3. In general, where increased diameter brush head portions are employed thicker twisted wire is also employed.

Man made filaments may also be employed in place of natural bristle. Typical man made filaments include polyamide, polyester, polybutylene terephthalate, and polyolefins such as polypropylene homopolymer, polyethylene or the like. The man made filaments typically have diameters ranging from 0.13 to 0.6 mm and can be both straight or crimped as required.

The efficacy of the cleaning brush 1 of Figure 2 as compared with the performance of a cleaning brush 1 of the prior art in which the filaments of the brush head 3 are formed from a single material was determined by comparing the performance of anchors resin bonded in holes that were cleaned with both brush types.

The tests were carried out in accordance with ASTM Standards E 1512-01, 488-96 and ETAG No.001 Part 5 which describe methods for the testing of anchors in both masonry and concrete and form the basis of the test methods outlined below.

Hole preparation

Holes were drilled into a concrete block by first marking positions for the anchor fixings on the concrete block using a drilling pattern for confined fixings. The required drill bit was selected and the diameter of the cutting edge measured. The length of the anchor fixing was measured and marked onto the drill bit. The selected drill bit was inserted into a rotary percussive hammer and a hole drilled in the concrete to the depth marked on the drill bit. Loose debris from the drilling process was removed with a vacuum cleaner. The hole was then cleaned with the appropriate cleaning brush and a blow pump (described further below). A chemical fixing resin was then extruded into the hole and a clean metal fixing rod was then inserted into the hole through the resin using a "backwards and forwards" twisting action. The resin was allowed to cure for 24 hours before testing.

Hole cleaning

Holes were cleaned with the cleaning brushes and an ABG (845ml) hole-cleaning pump. The regime was as follows:
1 blow, 2 brush, 2 blow, 2 brush and 1 blow where a blow is one full pump from the ABG hole cleaning pump and a brush is the application of the cleaning brush inserted to the bottom of the drilled hole and removed.

Testing method

Confined tensile tests were carried out using apparatus of the type described in ETAG No 001 Part 5, Clause 5, Fig. 5.2 and procedures outlined in ASTM 1512-01 and 488-96.

A load test was carried out for five anchor sizes, M8, M10, M12, M16 and M20. The tests were carried out for all bolt sizes in dry concrete while a test was performed for the M12 bolt in wet concrete also. Performance with an M12 is generally considered as a benchmark in the art.

The anchors employed were fully threaded metric rods complying with BS:3643 (Coarse Series). The hole dimensions required for each anchor size are described in Table 2 below.

Table 2 **Anchor size and corresponding drilled hole Dimensions**

Anchor Fixing Size	Hole Diameter/mm	Hole Depth/mm
M8	10	80
M10	12	90
M12	14	110
M16	18	145
M20	22	170

The resin employed was a bisphenol-A epoxy-acrylate type blended with acrylate and methacrylate monomers. The curing agent employed was dibenzoyl peroxide based.

The concrete substrate employed was a Class C20/25 concrete in accordance with the requirements of EOTA document ETAG Number 001 annex A, clause 2. In Examples 1 to 6, the concrete strength was 35 MPa. In Example 7, 29.5 MPa concrete was employed. Table 3 below describes the cleaning brushes of the type described in Figure 2 employed in the tests:

Table 3 **Specification for Cleaning Brushes Employed in Examples 1 to 6.**

Brush Type	Diameter/ mm	Bristle Length/ mm	Steel Length/ mm	Overall Length/ mm	Use in Hole Diameters/ mm
Bristle	14	80	-	80	10 - 12
	19	82	-	82	14 - 18
	29	75	-	75	22 - 26
Dual Filament	14	60	15	75	10 - 12
	19	60	15	75	14 - 18
	29	60	15	75	22 - 26
Steel	9.50	75	-	75	10
	12.25	75	-	75	12
	14.50	80	-	80	14
	18.00	80	-	80	18
	22.50	100	-	100	22
	26.00	100	-	100	26

1 Figures 3 to 8 illustrate the results of the tests.

The following tests were performed

Example 1

Table 4: Tests performed with M8 anchor in dry holes.

M8x10x80mm

Brush Type	Load/kN			
	Test 1	Test 2	Test 3	Mean
Dual Fibre	40.7	36.4	39.6	38.9
Steel	32.1	34.0	29.2	31.8
Bristle	27.3	25.8	26.8	26.6

Example 2

Table 5: Tests performed with M10 anchor in dry holes.

M10x12x90mm

Brush Type	Load/kN			
	Test 1	Test 2	Test 3	Mean
Dual Fibre	47.6	49.2	52.1	49.6
Steel	41.6	42.4	47.9	43.9
Bristle	49.7	30.7	30.9	37.1

Example 3

Table 6: Tests performed with M12 anchor in dry Holes.

M12x14x110mm

Brush Type	**Load/kN**			
	Test 1	Test 2	Test 3	Mean
Dual Fibre	85.5	82.4	86.0	84.6
Steel	71.3	64.3	73.5	69.7
Bristle	60.4	65.0	59.2	61.5

Example 4

Table 7: Tests performed with M12 anchor in wet holes.

M12x14x110mm

Brush Type	**Load/kN**			
	Test 1	Test 2	Test 3	Mean
Dual Fibre	62.1	59.7	50.9	57.6
Steel	42.6	51.3	45.2	46.4
Bristle	41.8	42.7	39.2	41.2

Table 8: Comparison of data for M12 anchor in dry and wet holes.

M12x14x110mm

Brush Type	Load/kN	
	Dry	Wet
Dual Fibre	84.6	57.6
Steel	69.7	46.4
Bristle	61.5	41.2

Example 5

Table 9: Tests performed with M16 anchor in dry holes.

M16x18x125mm

Brush Type	Load/kN			
	Test 1	Test 2	Test 3	Mean
Dual Fibre	76.3	80.1	79.4	78.6
Steel	74.8	51.9	43.0	56.6
Bristle	47.3	32.2	46.2	41.9

Example 6

Table 10: Tests performed with M20 anchor in dry holes.

M20x22x170mm

Brush Type	Load/kN			
	Test 1	Test 2	Test 3	Mean
Dual Fibre	100.8	123.4	124.8	116.3
Steel	108.0	109.3	102.9	106.7
Bristle	90.2	69.9	62.2	74.1

Example 7

The following brush types were tested for comparison purposes:

Brush Type	Brush Composition			
	Material	Length /mm	Material	Length/ mm
Control	White Chunking Bristle	60	Stainless Steel	15
Brush 1	White Chunking Bristle	60	Brass	15
Brush 2	PBT	60	Stainless Steel	15
Brush 3	PA	60	Stainless Steel	15

The Control was medium Dual Fibre. All brushes were 20 mm diameter.

Table 11: Comparison of loads versus brush type for M12x14x110mm in dry holes.

Brush Type	Load/kN					
	Test 1	Test 2	Test 3	Test 4	Test 5	Mean
Dual Fibre	64.4	61.2	73.2	83.1	62.0	68.8
Brush 1	61.7	55.0	61.7	91.8	80.5	70.1
Brush 2	71.3	64.2	75.9	68.7	55.9	67.2
Brush 3	64.0	67.9	56.3	61.0	74.1	64.7

The tests described above demonstrate that dual filament cleaning brushes in accordance with the invention consistently and significantly outperform single filament brushes namely natural bristle cleaning brushes and steel cleaning brushes in cleaning dry and wet drilled holes prior to injection of a resin bonding agent into the drilled hole. All other parameters being equal in each case, it is clear that the improved confined tensile test results achieved were as a result of the dual filament brushes of the invention.

Surprisingly, it was found that although natural bristle filament brushes of the prior art exhibited the poorest cleaning effect and the steel cleaning brushes of the prior art exhibited improved cleaning performance over the natural bristle cleaning brushes, the dual filament brushes of the invention made up of a ratio of natural bristle to steel filaments in the range of approximately 75:25 to 80:20 exhibited significantly increased performance over both cleaning brush types of the prior art.

The use of a combination of the steel filament portion and the natural bristle portion in the brush of the invention facilitated the use of a larger diameter steel portion (dimension F in Figure 2) than would normally be acceptable in a conventional all-metal cleaning brush of the prior art as the cleaning brush of the prior art would become locked or embedded in the drilled hole.

Although the applicants do not wish to be bound by any theorem, it is believed that the combination of the metal filament block and the natural fibre filament block in the cleaning brushes of the invention resulted in a synergistic effect whereby the stiff metal filaments were highly efficacious at loosening dust particles from the walls of the drilled hole while the low modulus or resilience of the bristles of the natural bristle block assisted in the conveying or removal of the loosened dust particles from the hole. In addition, upon retraction of the cleaning brush of the invention from the drilled hole, it is believed that the resilience of the natural bristles facilitates a "flicking" action of the bristles to eject dust particles from the drilled hole thereby enhancing cleaning of the hole to facilitate effective bonding of the resin between the anchor and the drilled hole.

Accordingly, the combination of the high modulus filaments of the steel filament block with the low modulus and elastic nature of the natural bristle block combined to produce a significantly improved cleaning effect.

Similarly, Example 7 and Figure 11 clearly demonstrate that a combination of natural brushes and brass, polybutylterephthalate (PBT) and steel and polyamide and steel also exhibit the synergistic effect of the natural bristle and steel described above. In the present example, the load for each brush type was less than that exhibited in Examples 1 to 6. This is believed to have resulted from the use of a concrete block of a differing compressive strength in Example 7.

It will be noted that the performance of the M16 anchor described in Figure 8 employing the dual fibre brush of the invention, although much improved over the performance of the steel filament brushes of the prior art nevertheless exhibited lower tensile capacities than that achieved with the M12 anchor shown in Figure 7. This is believed to have been the result of two factors, the relative shallowness of the hole and the relative dimensions of the brush diameter (dimensions F and H) and the drilled hole diameter. In the case of an M12 fixing the hole depth is 9.16 times the bolt diameter, whereas the M16 bolt is significantly less at 7.81 times. The cleaning brush of the invention employed for cleaning a hole having a diameter of 18mm for an M16 anchor itself has a diameter of approximately 19 to 22mm. Accordingly, the degree of overlap between each filament and the hole is of the order of 1 to 2mm. In contrast however, the degree of overlap with the small and large cleaning brushes and their respective drilled holes is typically greater than 2mm. It is believed that it is for this reason that the improvements in performance exhibited with the M16 anchor were somewhat reduced. However, the performance could be improved by increasing the filament length as required. Nevertheless, it should be noted that an important benefit of the cleaning brush of the invention is that three brushes only were required for use in cleaning holes ranging in diameter from 10mm up to 26mm as described in Table 3 above. In contradistinction, the steel cleaning brushes of the prior art must be manufactured to be peculiar to each drilled hole diameter.

Claims

1. A drill hole cleaning brush comprising a handle and a brush head on the handle formed from filaments wherein a first portion of the filaments is formed from a high modulus material and a second portion is formed from a low modulus material.

2. A drill hole cleaning brush as claimed in Claim 1 wherein the brush head comprises laterally extending filaments which project from the handle.

3. A drill hole cleaning brush as claimed in Claim 2 wherein the filaments are arranged in a helix about the handle.

4. A drill hole cleaning brush as claimed in Claim 3 wherein the first portion of high modulus material filaments and the second portion of the low modulus material filaments are arranged in blocks within the helical brush head.

5. A drill hole cleaning brush as claimed in Claim 4 wherein the first portion of the high modulus material filaments is disposed at a leading edge of the brush head.

6. A drill hole cleaning brush as claimed in any of Claims 1 to 5 wherein the high modulus

material filaments comprise a metallic material.

7. A drill hole cleaning brush as claimed in Claim 6 wherein the metallic material is selected from the group comprising steel, copper, brass and bronze.

8. A drill hole cleaning brush as claimed in Claim 7 wherein the metallic material comprises steel.

9. A drill hole cleaning brush as claimed in any of Claims 1 to 8 wherein the low modulus material comprises a natural or man made fibre.

10. A drill hole cleaning brush as claimed in Claim 9 wherein the low modulus material comprises a natural bristle.

11. A drill hole cleaning brush as claimed in Claim 10 wherein the natural bristle comprises a hog bristle.

12. A drill hole cleaning brush as claimed in any of Claims 1 to 8 wherein the low modulus material comprises a polymer.

13. A drill hole cleaning brush as claimed in Claim 12 wherein the polymer is selected from the group comprising polyolefin,

polybutylterephthalate, polyamide and polyester.

14. A drill hole cleaning brush as claimed in Claim 13 wherein the polyolefin comprises a polyethylene or a polypropylene

15. A drill hole cleaning brush as claimed in any of Claims 1 to 14 wherein the brush head comprises from 5 to 50% high modulus material filaments and from 95 to 50% low modulus material filaments.

16. A drill hole cleaning brush as claimed in any of Claims 1 to 15 wherein the brush head comprises from 15 to 35% high modulus material filaments and from 85 to 65% low modulus material filaments.

17. A method of cleaning a drill hole comprising cleaning the drill hole with a cleaning brush comprising a handle and a brush head on the handle formed from filaments wherein a first portion of the filaments is formed from a high modulus material and a second portion of the filaments is formed from a low modulus material.

18. Use of a drill hole cleaning brush having a brush head formed from filaments in which a first portion of the filaments is formed from a high modulus material and a second portion of

the filaments is formed form a low modulus material in the cleaning of a drill hole.

19. An anchorage system for installing an anchor member in a drilled hole in a substrate comprising an adhesive for setting the anchor member in the drilled hole and a drill hole cleaning brush having a handle and a brush head on the handle formed from filaments wherein a first portion of the filaments is formed from a high modulus material and a second portion of the filaments is formed from a low modulus material.

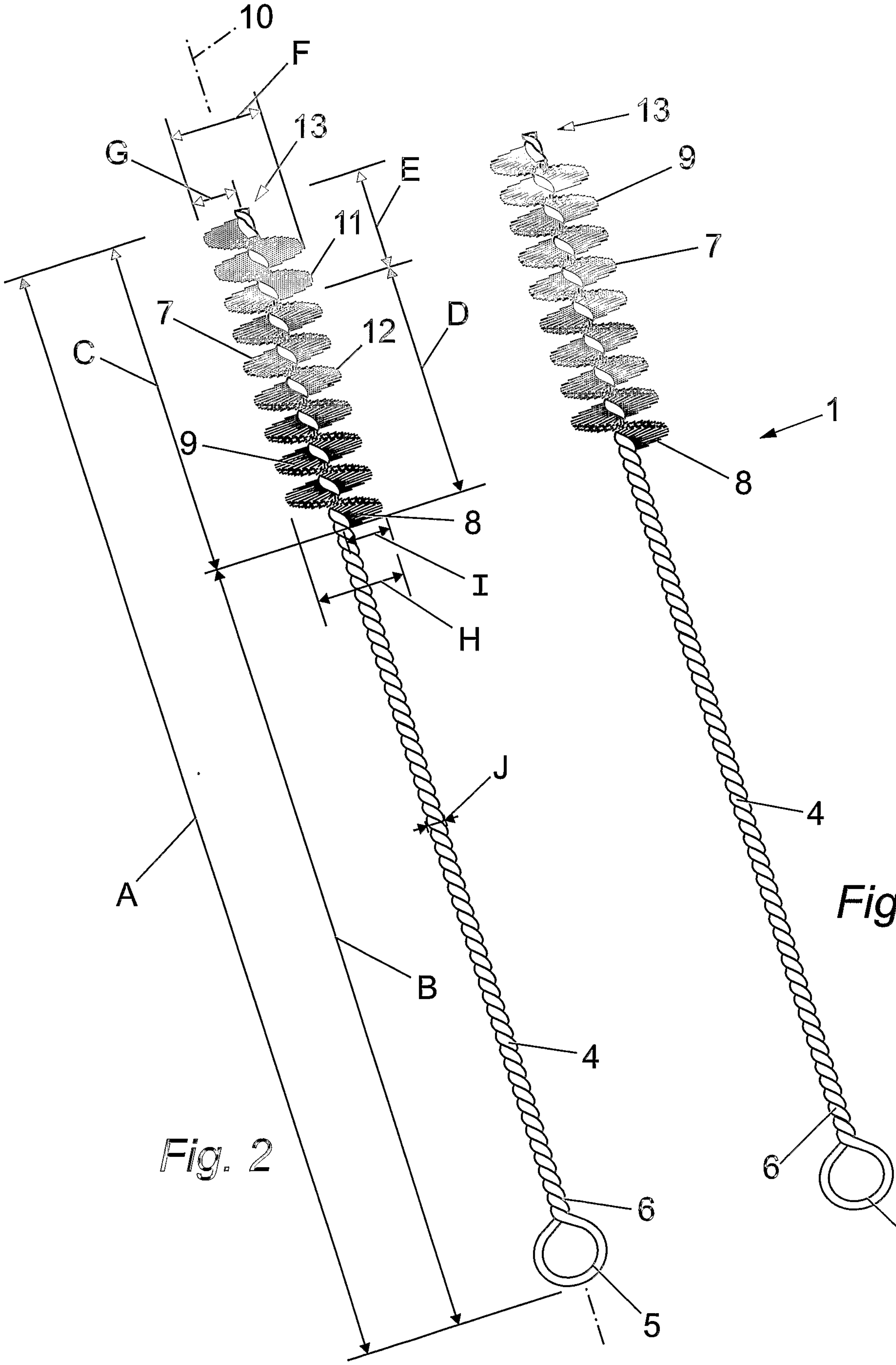


Fig. 1

Fig. 2

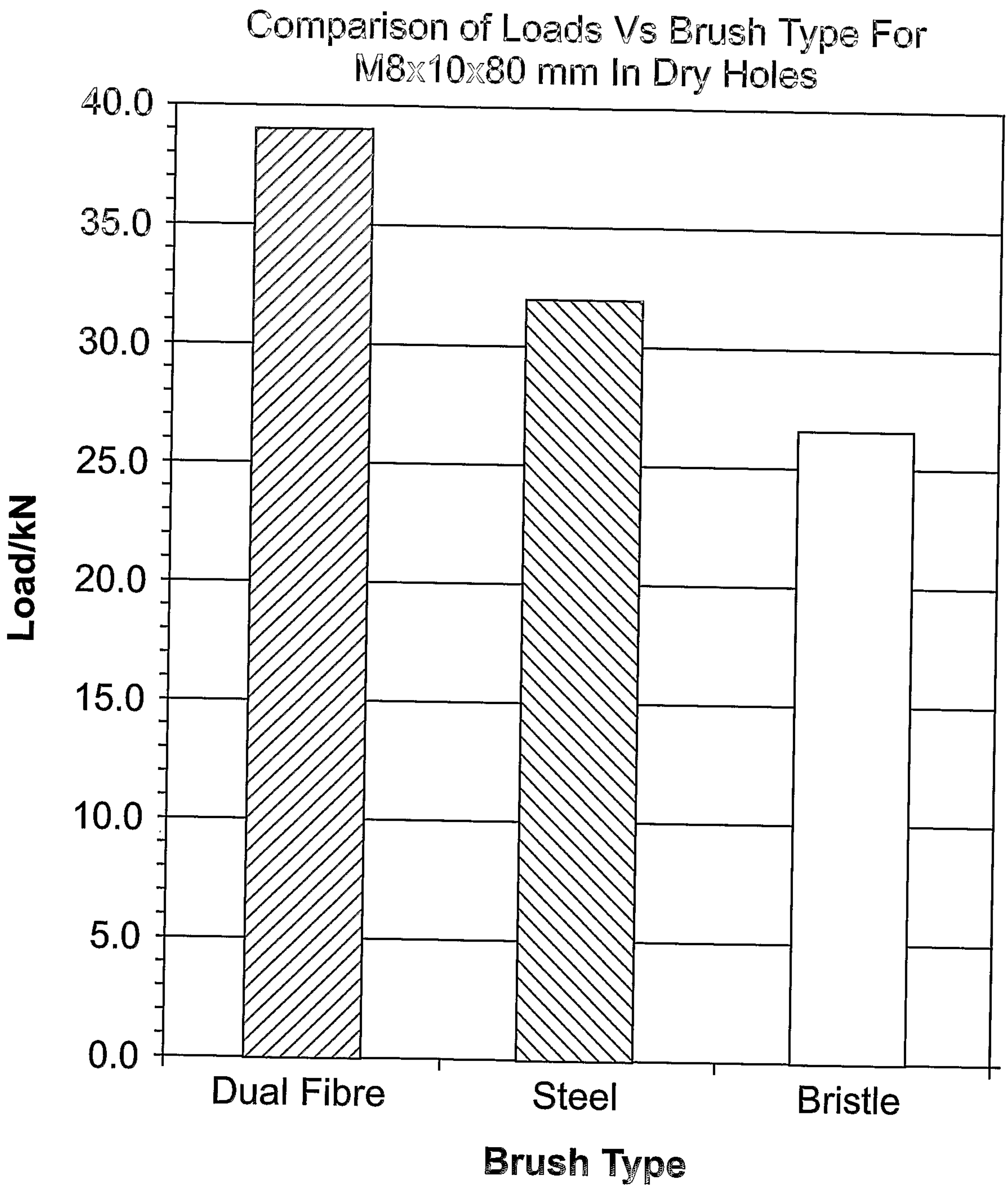
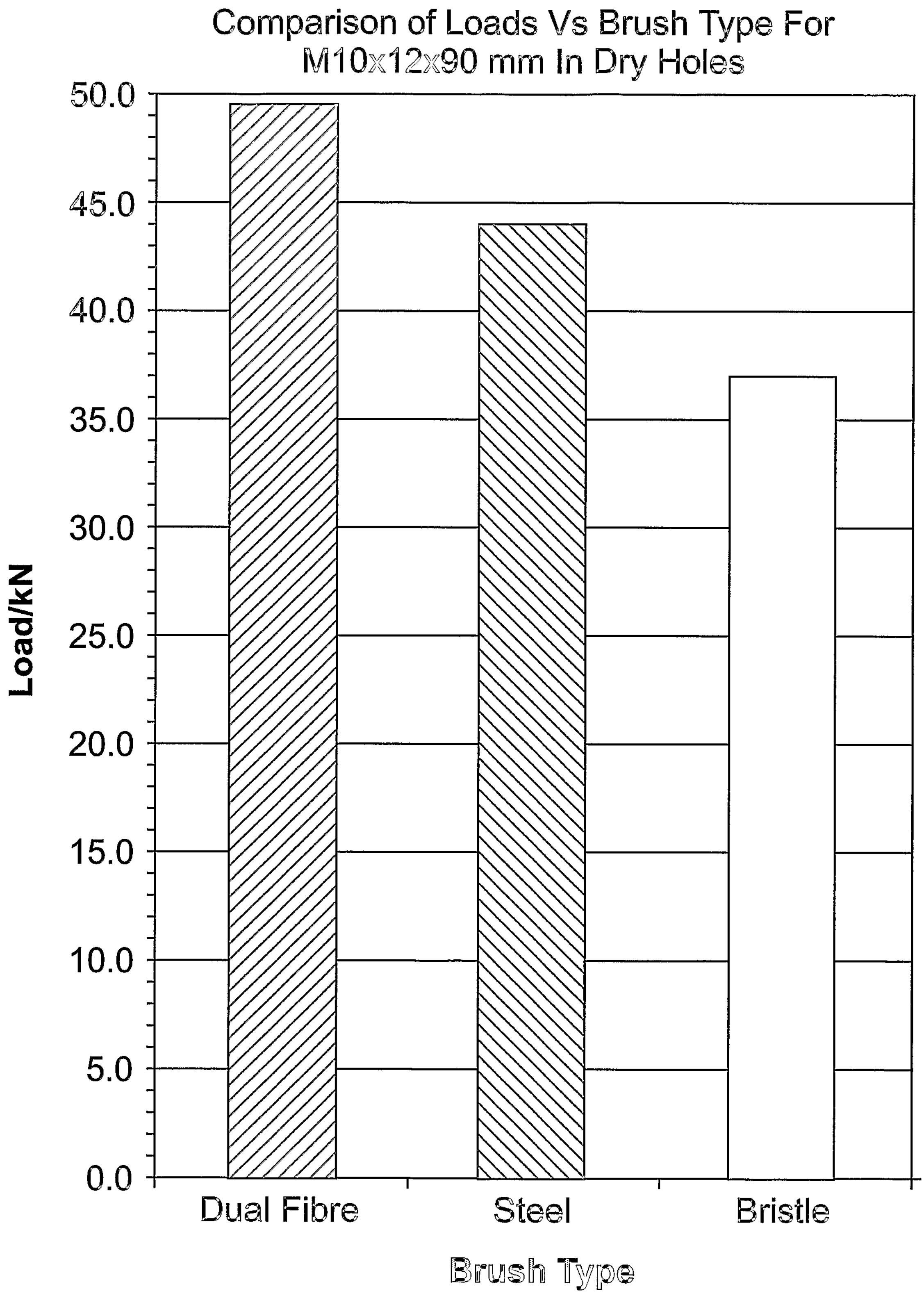

Comparison of Loads Vs Brush Type For M8x10x80 mm In Dry Holes
Load/kN
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Dual Fibre
Steel
Bristle
Brush Type

Fig. 3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Load/kN
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45.0
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25.0
20.0
15.0
10.0
5.0
0.0
Dual Fibre
Steel
Bristle
Brush Type

Fig. 4

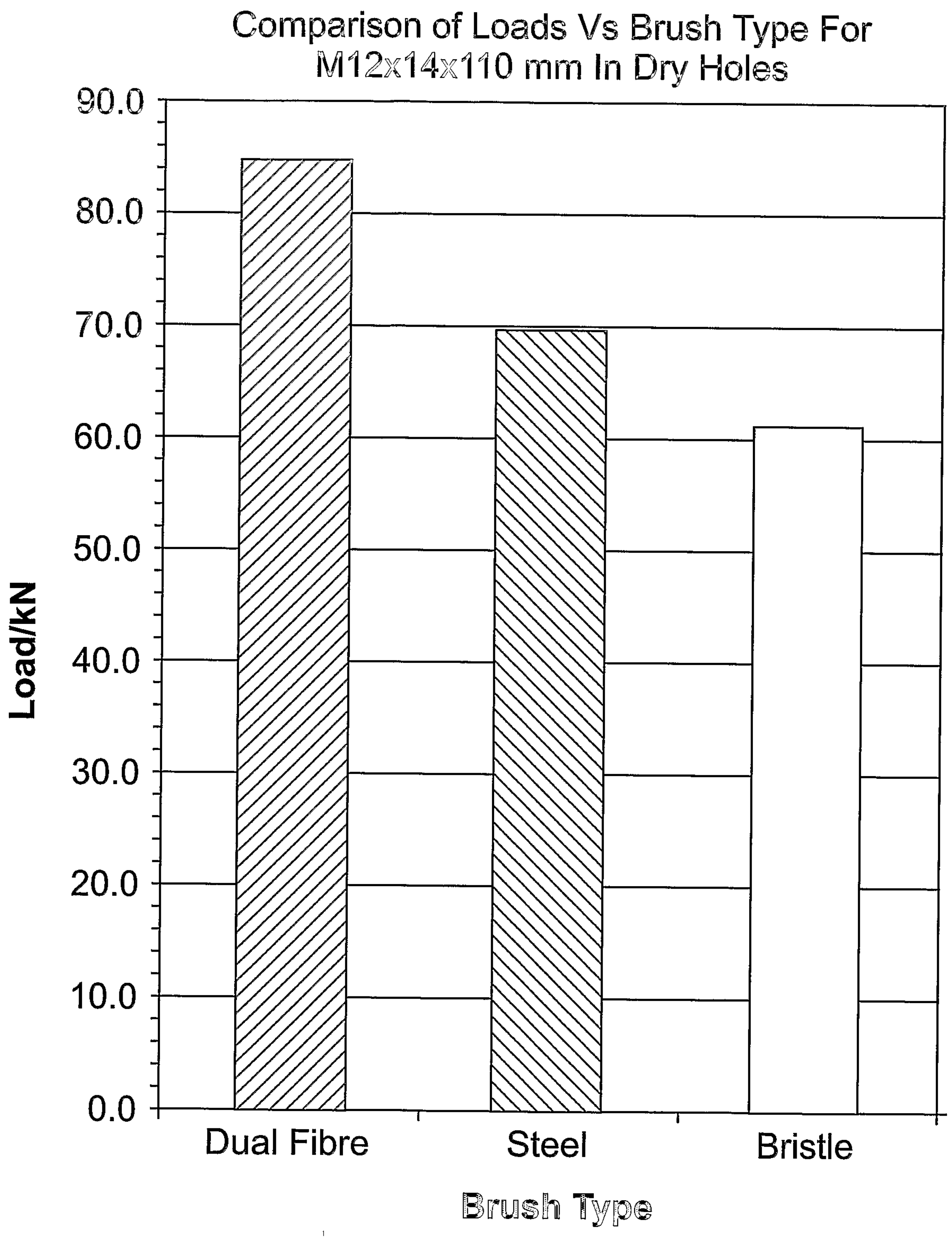

Comparison of Loads Vs Brush Type For
M12x14x110 mm In Dry Holes
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Load/kN
Dual Fibre
Steel
Bristle
Brush Type

Fig. 5

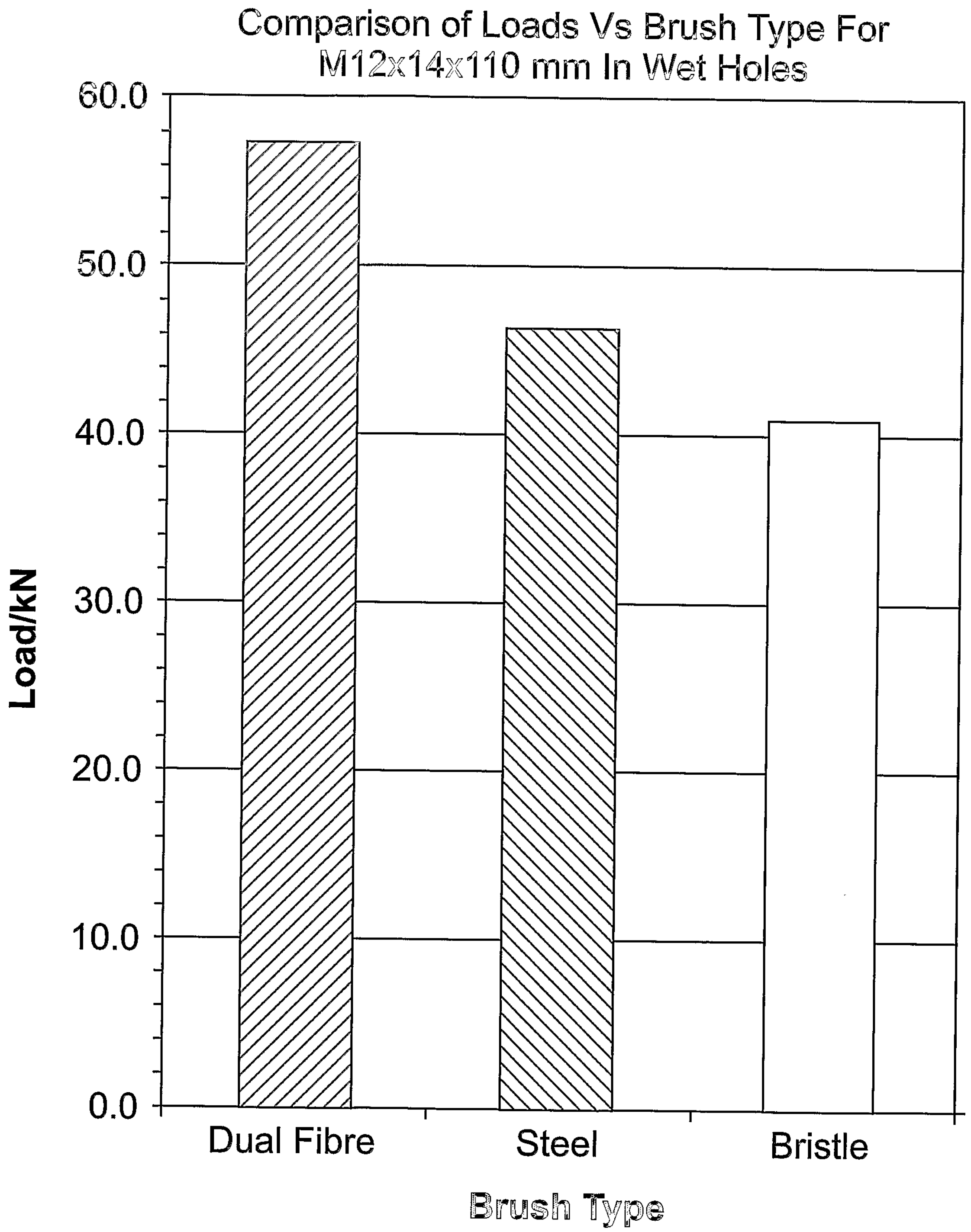

Comparison of Loads Vs Brush Type For
M12x14x110 mm In Wet Holes
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Load/kN
Dual Fibre
Steel
Bristle
Brush Type

Fig. 6

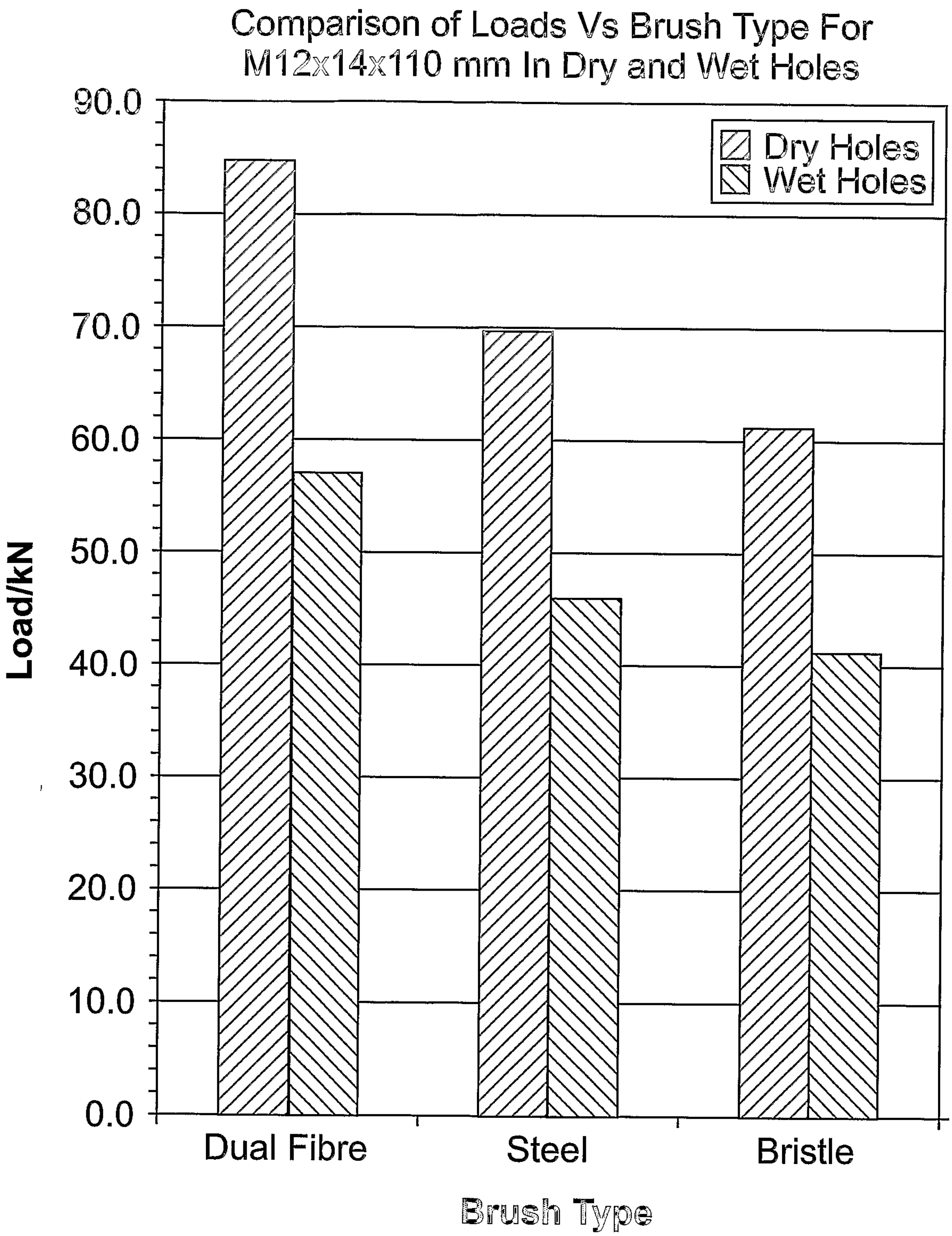

Comparison of Loads Vs Brush Type For M12x14x110 mm In Dry and Wet Holes
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Load/kN
Dry Holes
Wet Holes
Dual Fibre
Steel
Bristle
Brush Type

Fig. 7

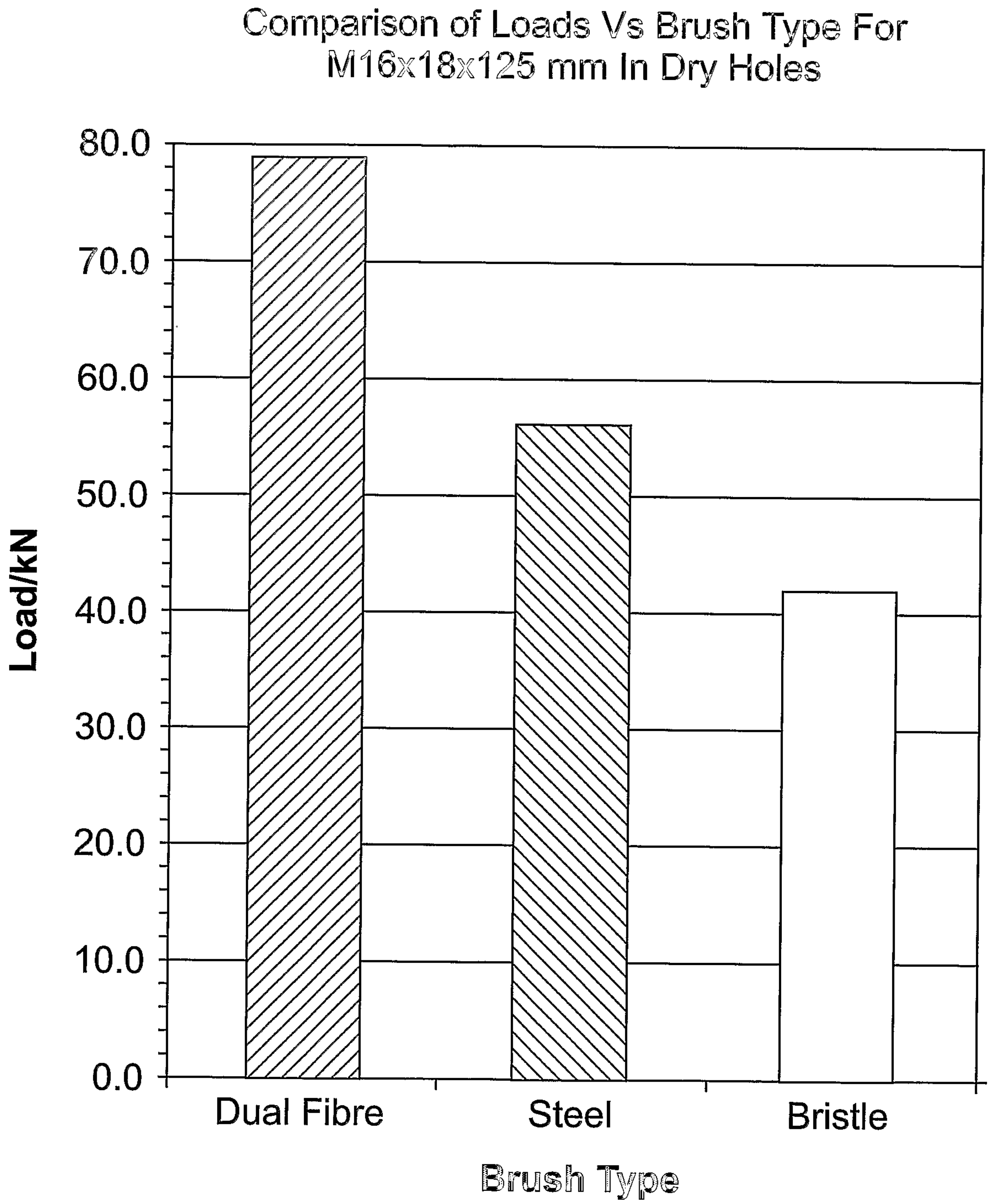
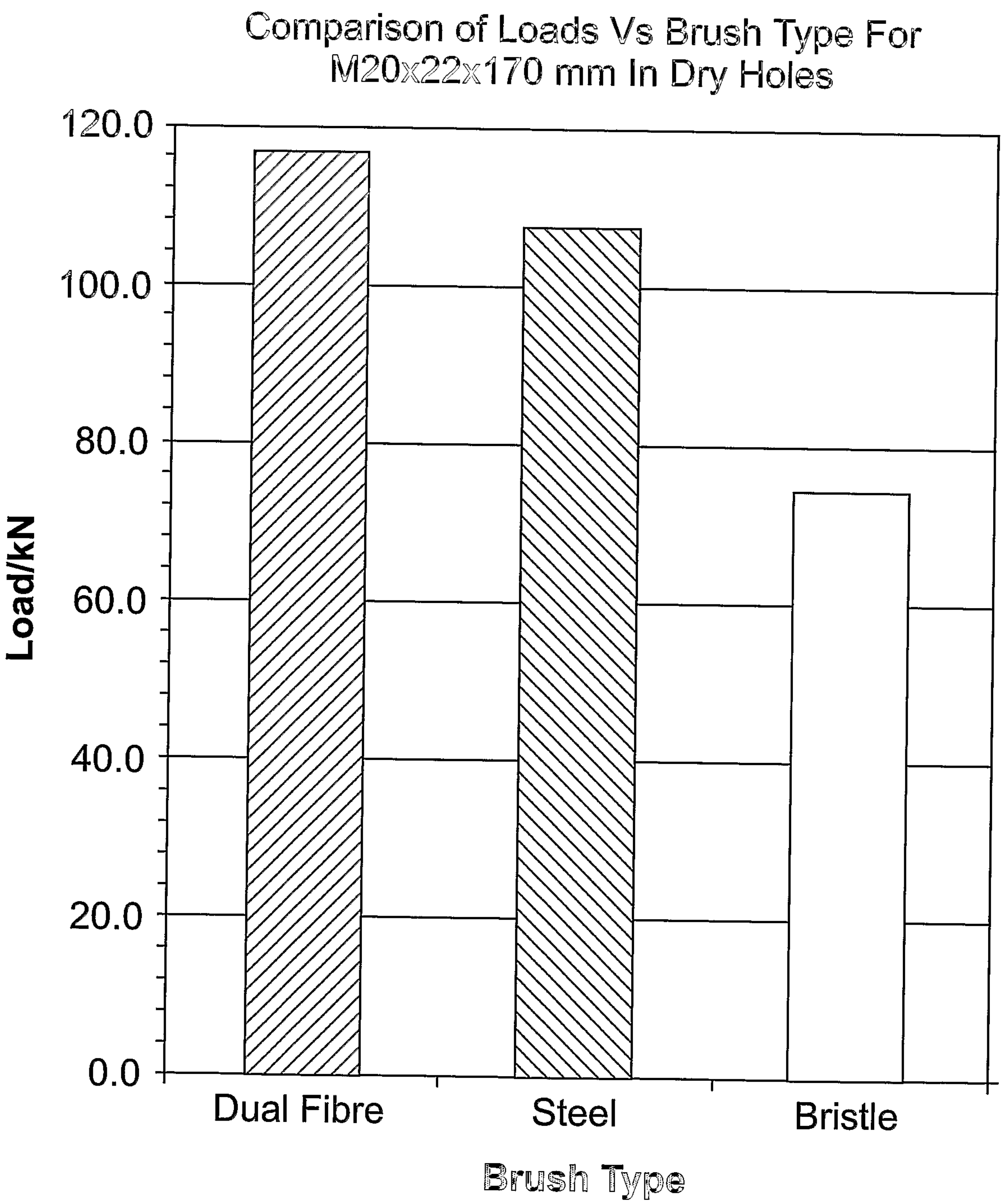

Comparison of Loads Vs Brush Type For M16x18x125 mm In Dry Holes
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Load/kN
Dual Fibre
Steel
Bristle
Brush Type

Fig. 8



Comparison of Loads Vs Brush Type For M20x22x170 mm In Dry Holes
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Load/kN
Dual Fibre
Steel
Bristle
Brush Type

Fig. 9

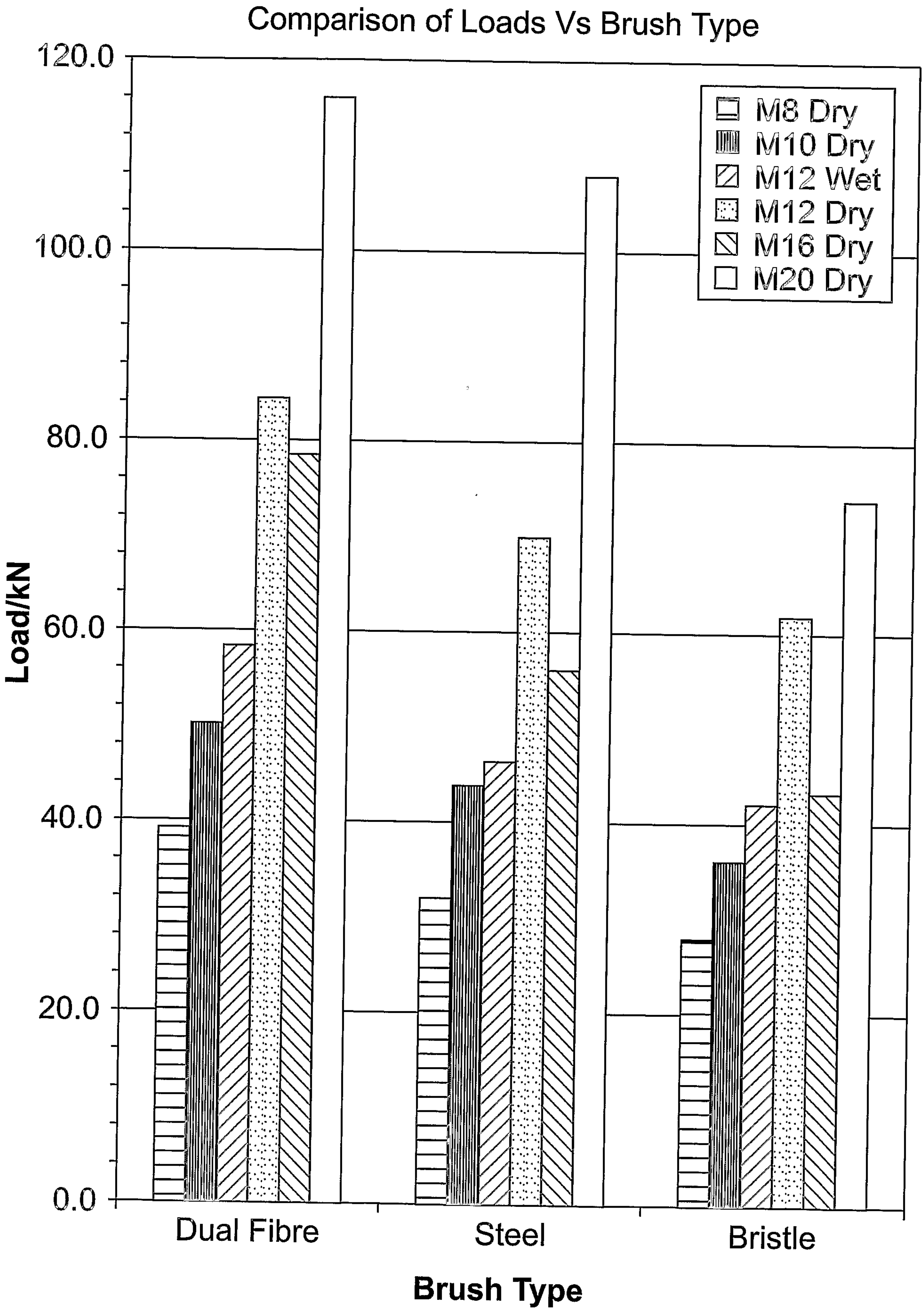

Comparison of Loads Vs Brush Type
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Load/kN
M8 Dry
M10 Dry
M12 Wet
M12 Dry
M16 Dry
M20 Dry
Dual Fibre
Steel
Bristle
Brush Type

Fig. 10

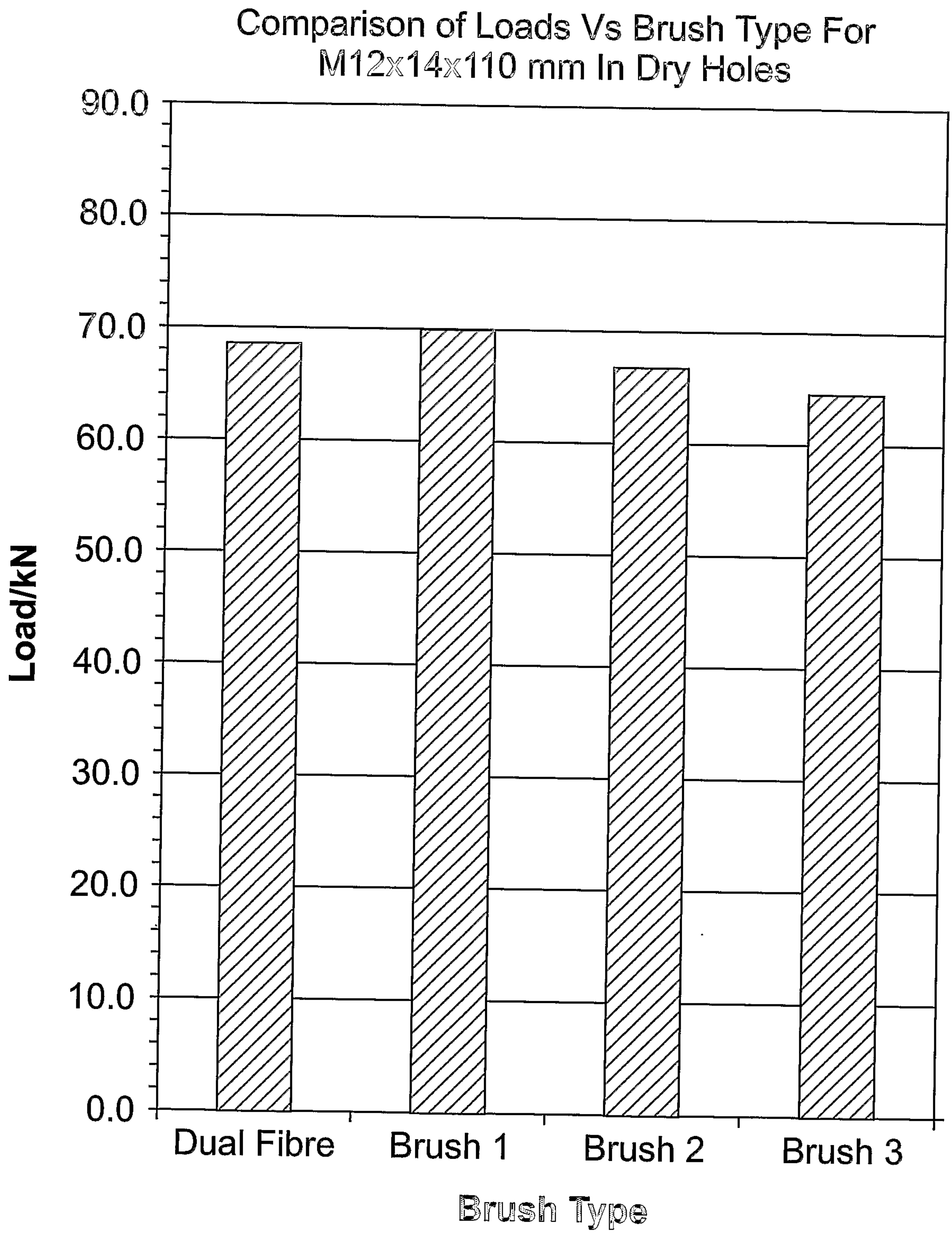

Comparison of Loads Vs Brush Type For
M12x14x110 mm In Dry Holes
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Load/kN
Dual Fibre
Brush 1
Brush 2
Brush 3
Brush Type

Fig. 11

INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB2004/000824

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A46B3/18 A46D1/00

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 7 A46B A46D

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

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y		3
Y	GB 1 230 503 A (STEVE ALBERT RANDS) 5 May 1971 (1971-05-05) page 2, left-hand column, lines 1-5 page 2, right-hand column, lines 89-91; figure 3	3
A	DE 24 23 433 B (SELL, RUDOF) 21 August 1975 (1975-08-21) column 4, lines 23-49; claim 1; figure 1	3,6,8,19

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"E" earlier document but published on or after the international filing date
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 July 2004	04/08/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	van Bilderbeek, H.

INTERNATIONAL SEARCH REPORT

In[illegible]al Application No
PCT/GB2004/000824

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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