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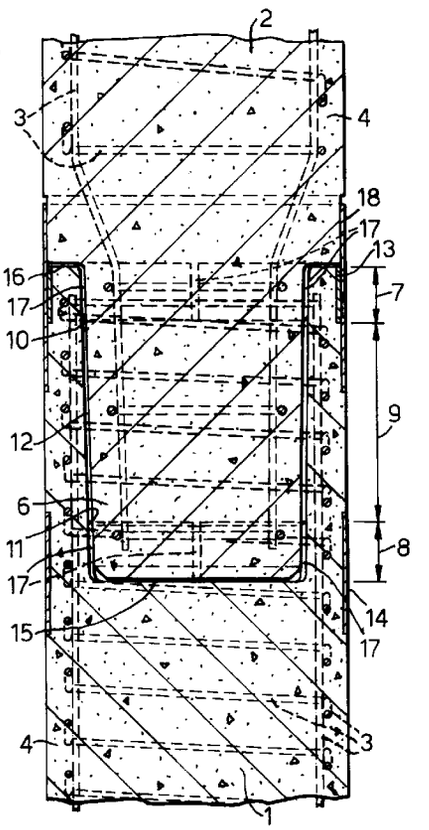
(54) Sectional concrete piles

(57) A concrete pile section (1,2) comprises an elongate body of reinforced concrete having a socket (5) at its top end and a spigot (6) at its bottom end which are shaped and relatively dimensioned such that when the spigot (6) at the bottom of one such section (1,2) is fully inserted into the socket (5) at the top of another such section (1,2) to form a joint there is an interference fit between the spigot (6) and socket (5) in at least two zones (7,8) spaced apart along the length of the joint but a clearance fit in at least a third zone (9) spacing the said two zones (7,8). The socket (5) is reinforced by at least one hoop member (13,14) in each of these two zones (7,8), preferably by a separate circular hoop member (19,20) embedded in the concrete in each of the zones (7,8). If desired, a resinous adhesive or a non-shrink grout may occupy the clearances in the third zone (9) and/or elsewhere. Even without such adhesive, however, the interference fit in the first and second zones (7,8) creates an immediate frictional engagement so that installation of the pile can continue immediately.

Fig.1.



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Description

This invention relates to driven piles for the support of buildings or other structures that are made in sections of reinforced concrete that are connected together by joints assembled as driving proceeds.

The joints between sections of such a pile must provide strength and stability to withstand the loads required for installing the pile, and should if possible do so immediately on assembly, without waiting for the curing of any adhesive, grout or the like. It is an object of this invention to meet these requirements economically.

In accordance with the invention, a concrete pile section comprises an elongate body of reinforced concrete having a socket at one end (intended as and hereinafter referred to as the top of the section) and a spigot at the other end (the bottom) and is characterised in that the spigot and socket are shaped and relatively dimensioned such that when the spigot at the bottom of one such section is fully inserted into the socket at the top of another such section to form a joint there is an interference fit between the spigot and socket in at least two zones spaced apart along the length of the joint but a clearance fit in at least a third zone spacing the said two zones and in that the socket is reinforced in each of the said two zones by at least one hoop member.

The invention includes a sectional pile including at least two such sections assembled as aforesaid.

By providing an interference fit in two spaced zones in this way, a good rigid joint can be obtained without making assembly too difficult, and the need for hoop reinforcement is limited to the two zones where there is interference fit (though a single hoop reinforcement embracing all three zones could be used if found economically viable).

The hoop members will normally be of steel, though other materials of sufficiently high tensile strength could be used. Preferably they are simple circular closed hoops, but other circular or non-circular structures, including structures with longitudinal members linking turns of a "spiral wire can be used ("spiral" as used in connection with reinforced concrete means a helix or its non-circular - including especially square - analogue of constant or varying pitch). Surprisingly, we have found that hoop members fully embedded in the concrete seem to be most effective to inhibit cracking during driving, but alternatively they may be exposed on the exterior of the pile, so as to support its entire cross-section: since their function is fulfilled during driving of the pile, it is not of great importance if they are susceptible to corrosion when the pile is in service.

The reinforcement, including the hoop members, may be of rolled welded steel mesh, of wire-tied cage construction, or any other conventional and suitable form.

For simplicity of stockholding, preferably all the sections of the pile are alike (except that in some cases it may be convenient for their lengths to differ) but if desired a special bottom section without a spigot and/or a special top section without a socket could be used, optionally with a reinforcing hoop member adjacent the bottom or the top respectively. Another option is to fit a metal or plastics shoe to the bottom of the first section to be driven.

Preferably the spigot and the socket are of circular cross-section in plan, but they could be of matching non-circular shapes providing they can be cast with the required precision. The shaft of the pile may be square, round, hexagonal, or of other plan cross-section.

Preferably the spigot and the socket are tapered in a broadly correponding way, each preferably comprising two conical sections of substantially the same cone angle demarcated by a step, the steps in the spigot and in the socket being spaced apart in the direction of the length of the section to form the boundaries between the said two zones. Alternatively the spigot may be parallel in each of the zones, preferably with a similar arrangement of steps so that interference occurs only in the last stage of assembly.

The pile sections in accordance with the invention can be assembled "dry", that is without the use of any kind of adhesive, but a further advantage of having two zones with interference fit spaced by a third zone with a clearance fit is that this clearance can when desired accomodate a resinous adhesive, non-shrink grout or other bonding material (preferably one with good shear strength) where it is not in danger of being squeezed out by the forces arising during installation of the pile.

There will normally need to be engagement between the bottom of the socket and the end of the mating spigot, and to ensure this while allowing reasonable manufacturing tolerances, it is desirable to allow for the insertion of a pad of solid, viscous or pasty material between them; similar pads may be used between any other substantial endwise-abutting pairs of surfaces. Suitable solid materials include rubbery or thermoplastic sheet materials, as commonly used to reduce damage to the ends of piles during driving; suitable viscous or pasty materials include the resinous adhesives, non-shrink grouts and the like already referred to as suitable for use as adhesives in the said third zone(s).

Since the forces available are sufficient to squeeze viscous or pasty resinous adhesive material or grout from the two zones of interference fit, appropriate distribution of the adhesive may be obtained simply by pouring the required amount (or a slight excess) into the base of the socket prior to inserting the spigot into it; alternatively if the properties of the material allow, it may be coated on the peripheral surface of the spigot and/or the socket in at least the third zone. In either case, it may be desirable to provide at least one groove to form a passage through each interference zone for the flow of any excess adhesive.

The invention will be further described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a diagrammatic longitudinal cross-section through a joint formed between the top end of one pile section in accordance with the invention and the bottom end of another;

Figure 2 is plan view of one of the sections;

Figure 3 is a diagrammatic longitudinal section of an alternative and preferred design of pile section in accordance with the invention; and

Figures 4 and 5 are enlarged details of the lower and upper ends of the pile section of Figure 3.

The joint seen in figure 1 is formed by the upper end of a first pile section 1 and the lower end of an identical pile section 2; pile section 1 is also seen in figure 2. The sections are of concrete with reinforcing steel 3 of any appropriate structure, and have square shafts 4 reducing to circular section at the joint region. The sections may be monolithic castings formed in a horizontal position in steel moulds having removable end sections for forming the joints, or end sections with projecting anchor bars may be cast separately in vertical moulds and integrated by casting the shaft in a horizontal position.

In accordance with the invention, the top end of the section 1 is formed with a tapered socket 5 (figure 2) and the section 2 with a mating spigot 6 (figure 1). The joint formed between spigot and socket comprises three zones 7, 8, 9; in zone 7 at the top of the joint and zone 8 at the bottom of the joint there is an interference fit between the spigot and the socket, giving immediate structural rigidity when the spigot is inserted into the socket; in the intermediate zone 9, demarcated from zone 7 by a step 10 between two equal-angled conical parts of the spigot 6 and from zone 8 by a step 11 between two equal-angled conical parts of the socket, there is a clearance 12 between the spigot and the socket. In the zones 7 and 8, the socket is reinforced by plain steel rings 13 and 14 respectively, which are exposed at the centres of the faces of the square-section pile but embedded at the corners. These hoops avoid any serious risk of the pile failing under the hoop stresses generated in installation of the pile, despite the fact that the taper of the spigot and socket may tend to increase these.

If there is a clearance 15 between the base of the socket and the distal end of the spigot, it should be filled with resin or other sufficiently strong padding material; the same may be done in any clearance 16 between the top of the lower section 1 and the contiguous face of the upper section 2.Grooves 17 extending through the zones 7 and 8 provide for the escape of any excess resin.

In this example, an additional metal sleeve 18, corresponding in shape to the square plan section of the pile, is spot-welded to the ring 13 and receives the lower end of the upper pile section 2 to assist alignment; the cross-section of the concrete may be reduced to accomodate this sleeve without projection.

In use, a first pile section is driven into the ground using a metal or plastics driving dolly temporarily inserted in the socket at its top end, and if ground conditions require it a metal shoe mounted on the spigot at its bottom end. When its top end approaches ground level, the driving cap is removed, and a quantity of a 2-part epoxy resin sufficient to fill the clearances 12 (and 15 and/or 16, if applicable) is mixed and either introduced into the socket or, if it flows slowly enough, coated onto the appropriate surfaces of the spigot; the next pile section is presented and its spigot inserted fully into the socket on the first pile section, causing the resin to flow if and as necessary, between the sides of the spigot and socket so that the clearances are substantially filled; in zones 7 and 8, however, the resin is substantially completely squeezed out from between the spigot and the socket giving direct concrete-to-concrete contact and thus a rigid frictional engagement allowing driving to continue without waiting for the resin to harden; on the other hand the interference fit in zones 7 and 8 is effective to prevent the resin from being squeezed out from the clearance 12 in zone 9.

In a specific example, the pile section has a general plan cross-section 235mm square; the spigot and socket are 250mm long, made up of top and bottom (first and second) interference zones 40 and 45mm long respectively with an intermediate (third) clearance zone 165mm long. The zones are delimited by steps with a radial height of 2mm superimposed on a uniform taper with a semi-angle of 1°30' between a diameter of 160mm at the narrow end of the bottom interference zone and about 177mm at the top of the top interference zone.

An experimental pile driven with sections according to this specific example has achieved an ultimate axial load-bearing capacity of 1MN in dense river gravel, similar to expectation for an unjointed pile.

The preferred pile section shown in figures 3-5 is generally similar to that of figures 1-2, and the same reference numerals have been used where appropriate for the corresponding parts. The only substantial difference is that instead of the external hoop members 13 and 14 simple welded hoops 19, 20 of steel rod are used: they are affixed to the longitudinal reinforcement (by tie-wires or if preferred by welding) and thus become fully embeded in the concrete of the pile. It has been our experience to date that these embedded hoops are more effective than the external hoop members 13, 14 in making pile sections that resist the tendency for fragments to break away adjacent to angles in the joint region.

Claims

1 A concrete pile section comprising an elongate body of reinforced concrete having a socket at one end (the top of the section) and a spigot at the other end (the bottom) and is *characterised in that* the spigot and socket are shaped and relatively dimen-

sioned such that when the spigot at the bottom of one such section is fully inserted into the socket at the top of another such section to form a joint there is an interference fit between the spigot and socket in at least two zones spaced apart along the length of the joint but a clearance fit in at least a third zone spacing the said two zones and in that the socket is reinforced in each of the said two zones by at least one hoop member.

2 A pile section as claimed in claim 1 in which said hoop reinforcement is limited to the first and second zones.

3 A pile section as claimed in claim 1 or claim 2 in which the or each hoop member is a closed circular hoop.

4 A pile section as claimed in any one of the preceding claims in which the spigot and the socket each comprise two conical sections of substantially the same cone angle demarcated by a step, the steps in the spigot and in the socket being spaced apart in the direction of the length of the section to form the boundaries between the said two zones.

5 A pile section as claimed in any one of the preceding claims in which the said hoop reinforcement is embedded in the body of the pile.

6 A sectional pile including at least two sections each as claimed in any one of claims 1-5 assembled together with the spigot of one said section frictionally engaged in the the socket of the other.

7 A pile as claimed in claim 6 in which a resinous adhesive, non-shrink grout or other bonding material occupies the clearance in the said third zone.

8 A pile as claimed in claim 6 or claim 7 having of a pad of solid, viscous or pasty material between endwise-abutting surfaces.

9 A pile as claimed in claim 6 assembled without any kind of adhesive.

10 A section as claimed in any one of claims 1-5 or a pile as claimed in claim 7 having at least one groove to form a passage through each interference zone for the flow of any excess adhesive.

Fig.1.

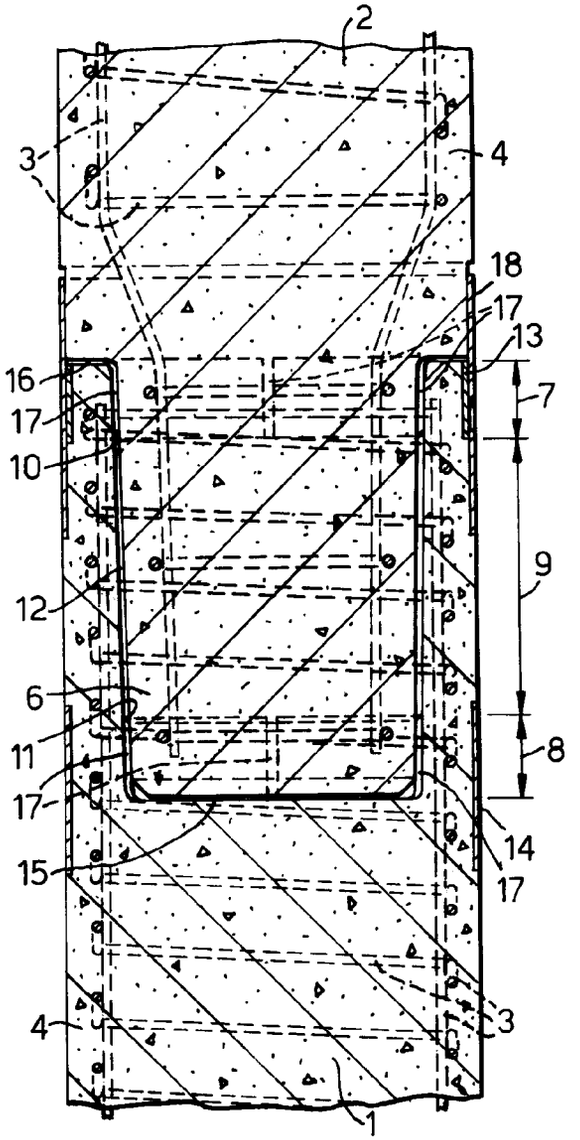


Fig.2.

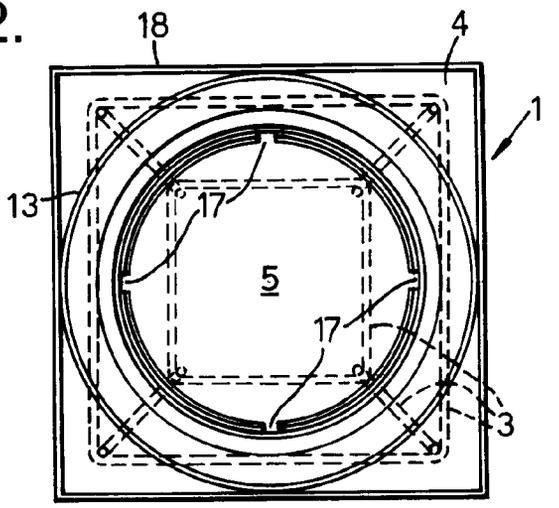


Fig.3.

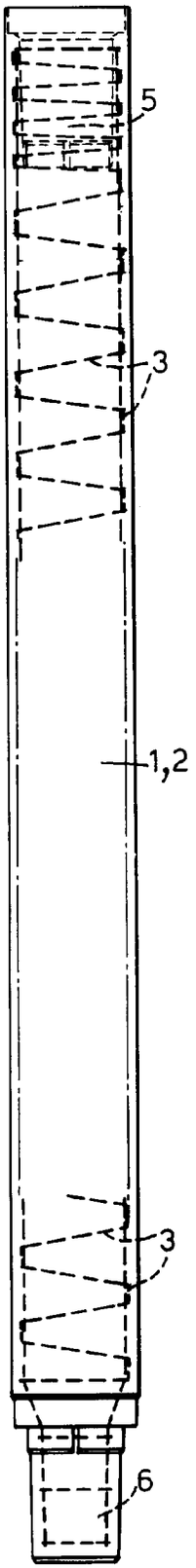


Fig.4.

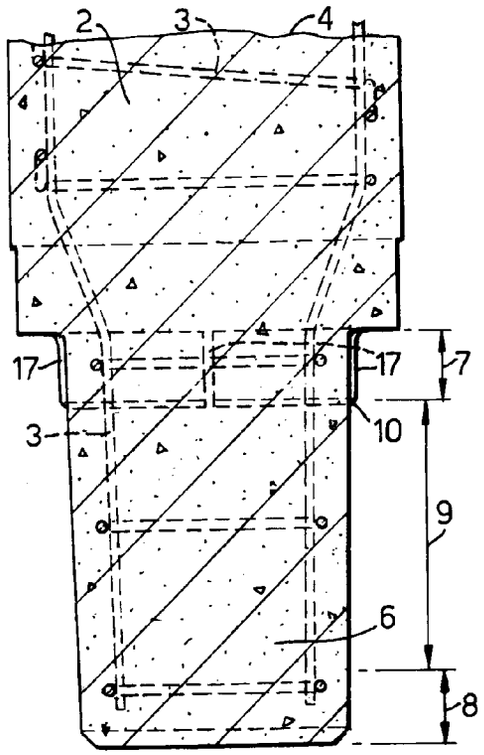
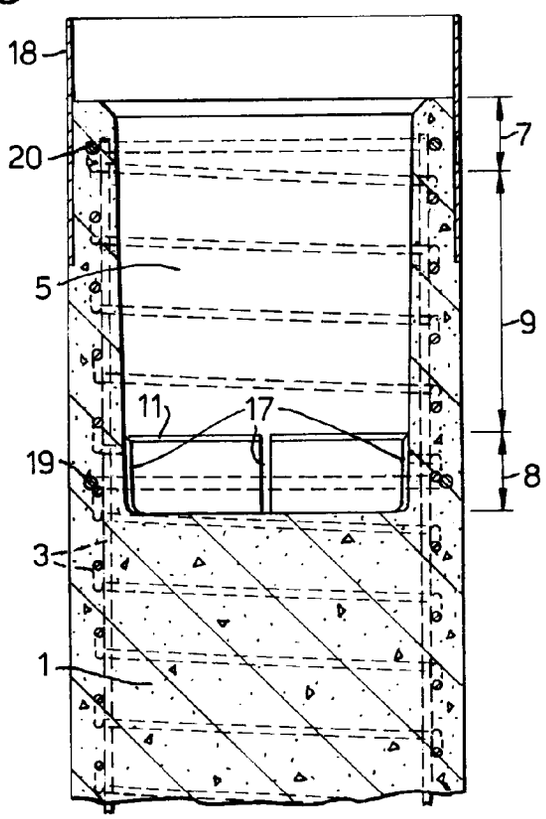


Fig.5.



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EUROPEAN SEARCH REPORT

Application Number
EP 95 30 4745

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	GB-A-521 683 (RICHES) 28 May 1940 * page 2, line 57 - page 4, line 68; figures 1-6 *	1,3-7,9	E02D5/52
A	FR-A-2 343 865 (QUADER ETS) 7 October 1977 * page 2, line 25 - page 5, line 16; figures 1-5 *	1-3,5-7	
A	NL-C-120 209 (WIT) 15 March 1948 * the whole document *	10	
A	EP-A-0 244 261 (PILECON ENGINEERING BERHAD) 4 November 1987		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 October 1995	Tellefsen, J

CATEGORY OF CITED DOCUMENTS

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