United States Patent

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[54] **CONCRETE PILE SECTIONS AND JOINTS THEREFOR**
3 Claims, 7 Drawing Figs.

[52] **U.S. Cl.** ..... **61/56,** 29/155 C, 29/160, 52/587
[51] **Int. Cl.** **E02d 5/30**
[50] **Field of Search** ..... 61/56, 56.5, 59, 53; 29/160, 155 C, 471.1; 52/587, 583, 725, 722, 301, 601; 285/189.36 B

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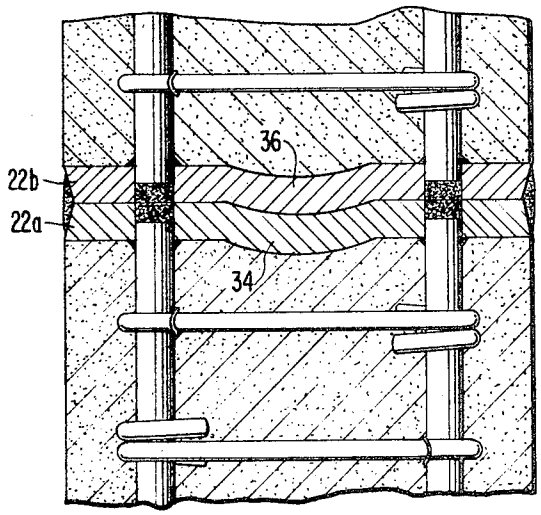
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ABSTRACT: Each cast concrete pile section has longitudinally extending reinforcing rods, the opposite ends of which are partially received within openings formed through normally disposed end plates. The rod ends extend intermediate the length of the openings and are welded to the end plates about the inside faces of the plates with weld also being applied externally within the openings from the outer faces of the plates. The edges of the end plates are beveled and the sectional piles are welded about the adjoining beveled edges in end to end relation. In one form, an end plate on one pile section is formed with a central concavity while the end plate on the adjoining pile section has a complementary central convex portion adapted to be received within the concavity as to align the piles in coaxial relation one to the other.



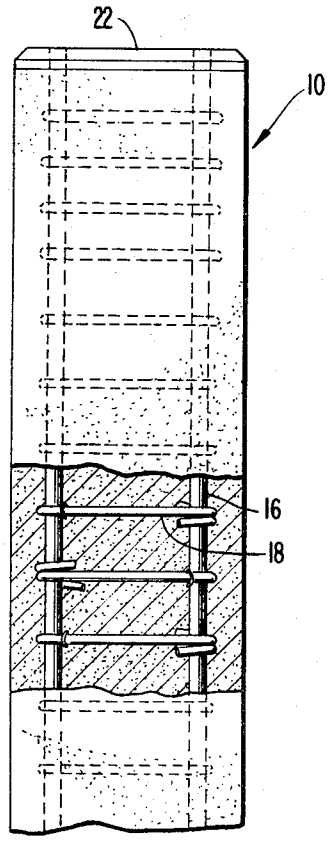


FIG. 1

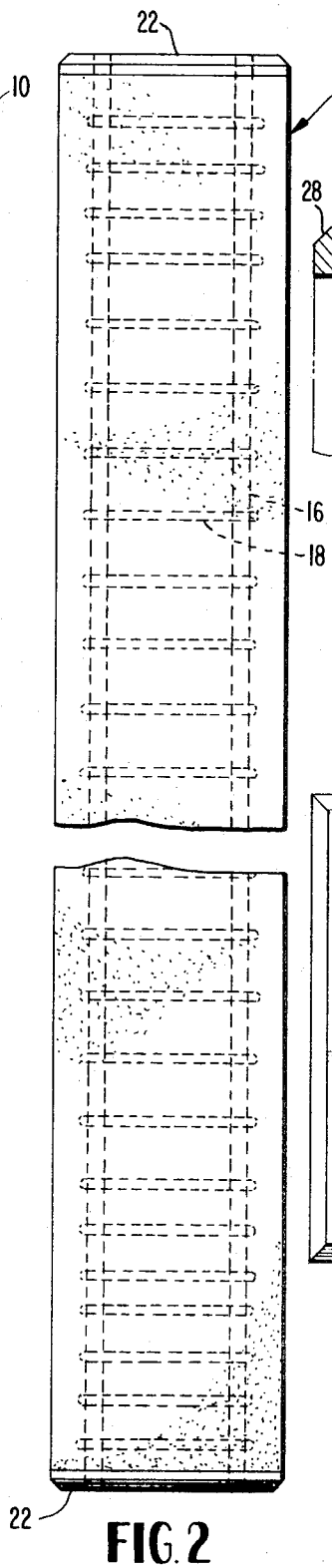


FIG. 2

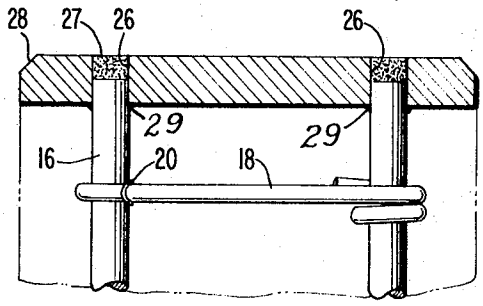


FIG. 3

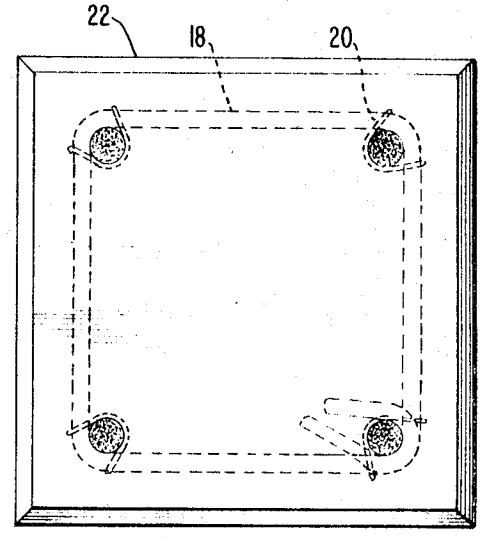


FIG. 4

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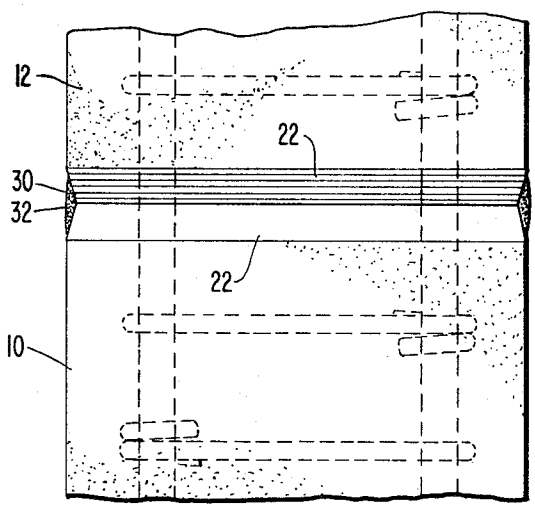


FIG. 5

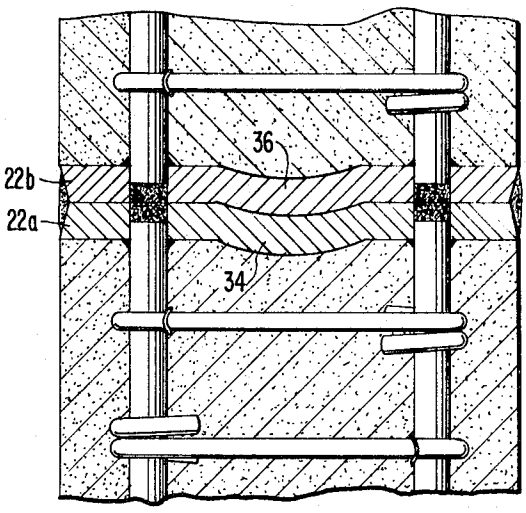


FIG. 6

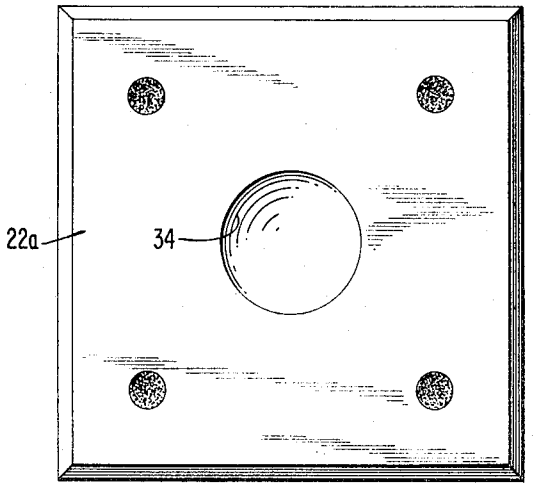


FIG. 7

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CONCRETE PILE SECTIONS AND JOINTS THEREFOR

This present invention relates to concrete pile sections and the joints therefor. Particularly, the present invention relates to precast concrete pile sections having end plates uniquely welded to the associated reinforcing rod ends in a manner to significantly increase the stress resisting characteristics of the pile sections during handling and welded to the end plates of adjoining concrete pile sections whereby a continuous cast concrete pile may be formed. Also, the present invention provides concrete pile sections which are readily and automatically coaxially aligned when joined one to the other to form a pile.

Cast reinforced concrete piles are widely used as foundations in the construction of buildings, bridges, and other structures. Due to their extremely heavy weight and for reasons to be described presently, concrete piles are most often formed in short lengths or sections at a casting or fabrication yard and these sections are then normally transported to the construction site whereupon they are disposed vertically and driven into the ground as by a suitable hammer. For most heavy construction, it is customary to join the precast concrete pile sections one to the other in end to end relation to form an elongated continuous pile and this may be accomplished either prior to or during the pile driving operation.

Certain problems, however, have remained in the construction and use of concrete pile sections, particularly with respect to the forces on the pile sections encountered during transport and handling of the pile sections prior to driving the same into the ground, as well as problems associated with joining the pile sections in end to end relation prior to or during pile driving operations. The widespread employment of concrete piles as foundation structures has resulted largely from the high load-bearing capability of concrete in compression. However, a concrete structure, particularly an elongated concrete pile, exhibits comparatively little load bearing capability in tension and under lateral loading. It will be appreciated that a precast concrete pile section acts as a beam when handled or stored or when loaded otherwise then in axial compression. Such pile sections, particularly those having large cross sections, are extremely heavy and, when transported from the casting yard to the construction site or otherwise handled prior to being driven into the ground, are thus subject to tensile and lateral loadings. These loadings, if excessive, tend to crack or otherwise damage the pile sections rendering the same unsuitable for use. Reinforcing rods are normally employed to impart stress-resisting characteristics to concrete pile sections. This has, to some extend, limited the damage to the pile sections during handling, but such damage still occurs and remains a problem.

Precast reinforced concrete pile sections have been employed previously and provided with metal end-connecting devices for joining pile sections in end to end relation to form a continuous concrete pile. In one such precast concrete pile, cylindrical rings are formed about and axially spaced from the opposite end portions of the concrete pile sections and the end portions of the reinforcing rods are bent or flared outwardly such that the rod ends are welded to the respective inner faces of the rings. To join these pile sections in endwise butting relation one to the other, a cylindrical sleeve or a pair of half sleeves are disposed about the adjoining ends of the pile sections with opposite ends of the sleeve or half sleeves being welded to the respective rings. Another known type of precast concrete piling section provides outwardly flared or bent reinforcing rods which are welded to the inside faces of annular end plates and to the inner faces of metal rings which are, in turn, welded to the associated annular end plates. To join the pile sections one to the other in endwise butting relation the annular end plates are butted one to the other and welded about their common periphery.

The foregoing pile sections have only limited load-bearing characteristics in tension and are accordingly subject to damage during handling. For example, when the foregoing and other pile sections are lifted or otherwise handled, the loadings are characteristic of beams with one side of the pile sections being subjected to loading in tension and the other side being subjected to loading in compression. Since the reinforcing rods of the foregoing described known pile sections on the sides thereof in tension are bent or flared outwardly, it will be seen that their tension bearing characteristics are seriously impaired and the pile sections are thus subject to cracking along their tensioned sides. More importantly, the rod-to-ring connections and the rod-to-end plate connections where applicable of such prior pile sections afford limited weld areas whereby the joints are not particularly strong and often rupture. Since these connections are internal of the pile sections, visual inspection of these connections prior to installation is impossible. Moreover, in those pile sections employing outwardly bent or flared reinforcing rods, the axial force applied to the sections when the latter are the driven into the ground tends to further deflect the flared or bent ends of the rods outwardly such that the rods tend to crack the concrete cover between the rods and the outer surfaces of the pile sections.

The present invention provides reinforced concrete pile sections and joints therefor which minimize the above-discussed and other shortcomings of prior concrete pile sections and their associated joints and provides various advantages in construction, mode of use and result over such prior pile sections and joints. Generally this is accomplished by forming concrete pile sections in the usual manner and providing plates at opposite ends of the pile sections with holes bored or otherwise formed therethrough to receive the associated ends of longitudinally extending reinforcing rods. The ends are partially received within the plate openings and terminate short of the outer faces of the plates to form recesses with the remaining portions of the openings. The rods are welded to the plates internally of the pile sections about the rods and along the inside face of the plates about the openings as well as externally in the recesses about the walls of the openings of the associated rod end faces. In this manner the rod ends are welded at two areas thereby providing a large and significant increase in weld area and hence a stronger rod-to-end plate connection than previously formed. Equally as important, the rods extend longitudinally in parallel relation to the corresponding axes of the pile sections throughout the full lengths of the latter. By increasing the weld area and hence the strength of the weld joint as well as forming the rods parallel to the respective axes of the pile sections throughout their full lengths, there are provided concrete pile sections having improved load-bearing characteristics in tension whereby cracking and other damage to the pile sections during handling is substantially eliminated.

It is another significant feature of the present invention that the pile sections can be readily, accurately and automatically coaxially aligned when disposed in end-to-end relation and driven into the ground. To this end, an end plate on each of the pile sections is provided with a central concavity. The opposite end plate of each pile section is provided with a corresponding central convexity and it will be appreciated that when the pile sections are superposed one over the other, the convexity on the lower end of the superposed piling section engages within the concavity formed on the upper end of the underlying pile section, thus coaxially aligning the pile sections.

Accordingly, it is a primary object of the present invention to provide improved concrete pile sections and joints therefor.

It is another object of the present invention to provide concrete pile sections having improved load-bearing characteristics during handling.

It is still another object of the present invention to provide improved concrete pile sections which may be readily handled prior to installation substantially without danger of cracking or otherwise damaging the pile section.

It is a further object of the present invention to provide improved concrete pile sections having end plates uniquely con-

nected to the ends of the reinforcing rods to afford extremely strong joints therebetween and which sections may be readily joined one to the other in end-to-end butting relation.

It is still a further object of the present invention to provide concrete pile sections which in use may be readily, accurately and automatically coaxially aligned one with the other.

It is a related object of the present invention to provide concrete pile sections having end plates formed to afford large weld areas when the end plates of adjoining pile sections butt one another thereby to form a strong joint therebetween.

It is a further related object of the present invention to provide improved concrete pile sections which may be readily and easily formed and joined one to the other at minimum cost and labor.

These and further objects and advantages of the present invention will become more apparent upon reference to the following specification, appended claims and drawings wherein:

FIG. **1** is a side elevational view of a lowermost concrete pile section constructed in accordance with the present invention and having portions broken out and in cross section for ease of illustration;

FIG. **2** is a side elevational view of a superposed concrete pile section with portions broken out for ease of illustration;

FIG. **3** is an enlarged fragmentary cross-sectional view of an end portion of pile section hereof illustrating reinforcing rod-to-end plate connections;

FIG. **4** is a plan view thereof;

FIG. **5** is an enlarged fragmentary side elevational view of a joint formed between a pair of pile sections;

FIG. **6** is a fragmentary enlarged cross-sectional view of another form of piling connections constructed in accordance with the present invention; and

FIG. **7** is an enlarged plan view showing the upper end plate of the lower piling section illustrated in FIG. **6**.

Referring now to FIGS. **1** and **2**, there is illustrated two reinforced concrete pile sections generally indicated at **10** and **12** respectively, which may be formed in the usual manner as by pouring concrete into forms, molds or the like. Pile sections **10** and **12** are preferably rectangular in cross section, although it will be appreciated that the present concrete pile sections may be formed to other and different cross sections, for example, circular. The lower end of pile section **10** is tapered as at **14** and this type of pile section is employed as the initially driven section, the tapered end **14** facilitating the penetration of the pile section **10** into the ground. Pile section **12** is substantially constant in cross section throughout its full length and in use one or more pile sections **12** are disposed and connected in end-to-end relation one with the other and with pile section **10** to form a substantially continuous elongated concrete pile.

To form the pile section, a plurality of metal, preferably steel, reinforcing rods **16** are arranged in the form of an elongated cage having preferably a rectangular cross section. A plurality of metal ties **18** are wrapped about and encompass the rods **16** at longitudinally spaced position along the pile sections and are secured to rods **16** prior to pouring the concrete by light wires **20** in the usual manner.

In accordance with the present invention, end plates **22** are uniquely secured to the opposite ends of the reinforcing rods **16** forming the pile sections **12** with an end plate **22** being likewise secured to the upper ends of the rods **17** forming pile sections **10**. The lower tapered end of pile section **10** may be provided with a metallic end cap **24** to facilitate penetration of the initial pile section into the ground without damage to the concrete. End plates **22** are disposed normal to the long axis of the pile sections **10** and **12** and have like cross sections as the pile sections, i.e., have rectangular cross sections as seen in FIG. **4**. Each plate **22** is provided with a plurality of openings **26** which receive the ends of reinforcing rods **16**. It is a significant feature hereof that the strength of each of the rod-to-plate connections is significantly increased over known reinforcing rod-to-plate connections due to the unique manner of such connection as will now be described.

End plates **22** are slipped over the ends of rods **16** such that the latter are partially received within openings **26**. Preferably, the end of each rod extends halfway within its associated opening **26** leaving an outwardly opening recess **27** formed by the remaining sidewall portions of opening **26** and the end face of rod **16**. To secure the plates to the rods in a manner such that the joint has extremely high strength, is each rod is welded to the associated plate at two areas: about the rod end along the inner face of plates **22** about openings **26** providing an interior weld as at **29** in FIG. **3**, and within the recess **27** defined by the sidewalls of the openings **26** and the end face of rod **16** providing an external weld. Weld is preferably applied to each of these areas with weld being disposed within the recess **27** such that this external weld lies flush with the end face of the associated plate. In this manner, the weld area is greatly increased providing increased joint strength. Note that rods **16** extend longitudinally parallel to the elongated axis of the finished concrete pile sections throughout their full lengths and that tension applied to end plates **22** is transmitted directly between the end plates by the reinforcing rods **16** without significant tensile stress applied through the concrete. The peripheral edges of end plates **22** are partially tapered or beveled as at **28** and may be fully tapered as at **30** in FIG. **5**.

Referring now to FIG. **5** and to form an elongated pile, pile section **12** is coaxially aligned with and disposed above pile section **10** such that its lower end plate **22** lies flush against the upper end plate **22** of pile section **10**. The adjoining plates are then welded one to the other about the tapered edges **28** or **30** as the case may be. By tapering the edges of plates **22**, an increased weld surface area is provided thereby greatly increasing the strength of the resulting joint. Note that when the pile sections **10** and **12** are properly aligned one with the other the corresponding reinforcing rods in each section are coaxially aligned with the corresponding rods in the other section. Tensile loadings applied to the joined pile sections are transferred from one section to the other through the reinforcing rods and end plates of the one section directly to the end plate and reinforcing rods of the other section. In this manner, the joined pile sections do not transmit tensile loadings to the concrete portions thereof.

It will be appreciated that additional pile sections **12** may be secured to the upper end plate of pile section **12** illustrated in FIG. **5** similarly as the joint between pile sections **10** and **12** is formed thereby affording a continuous elongated concrete pile.

In another embodiment hereof, the end plates **22** are uniquely formed to facilitate axial alignment of the superposed pile sections and the underlying pile sections and to insure a flush engagement between their adjoining end plates. To this end, a centrally located projection or concavity **34** is formed in end plate **22***a* of each of the pile sections and in the end plate of pile section **10**. A corresponding centrally located projection or convexity is formed in end plate **22***b* at the opposite end of each of pile sections **12**. In this manner, when pile sections **10** and **12** are vertically disposed in endwise butting relation, it will be seen that convexity **36** is received within the concavity **34** thereby assuring axial alignment of the sections and precluding lateral movement of one pile section relative to the other. If the pile sections are laterally offset or axially misaligned when first vertically disposed one over the other, the arcuate surfaces or projections **34** and **36** cooperate such that the superposed pile section naturally or automatically slides into axial alignment with the underlying pile section.

It will thus be seen that the strong joints formed between the end plates and the reinforcing rods as well as the provision of rods extending longitudinally parallel to the axis of the concrete pile sections throughout their full lengths provide pile sections uniquely formed to have improved load-bearing characteristics in tension, particularly those loads applied during handling. When the concrete pile sections act as beams during handling, one side of each section is in compression

and its other side is in tension. The side loaded in compression is resisted by the concrete in the usual manner. The other side loaded in tension is resisted by the reinforcing rods without transmitting the tensile loading to the concrete. In this manner, vastly improved pile sections are provided in that the concrete thereof is not cracked or otherwise damaged, particularly during handling. Moreover, the end plates have tapered edges affording large weld areas whereby the pile sections may be readily welded one to the other to form extremely strong joints. In another embodiment, the end plates are uniquely formed such that the concrete pile sections may be readily and automatically disposed in axial alignment one with the other.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What I claim and desire to be secured by U.S. Letters Patent is:

1. A pile construction comprising upper and lower concrete pile sections each having a plurality of laterally spaced, longitudinally extending reinforcing rods, a plate disposed at the lower end of said upper pile section, a plate disposed at the upper end of said lower pile section, each of said plates lying, substantially normal to the longitudinal axis of the respective pile sections thereof and having a plurality of openings for receiving the corresponding ends of the associated rods, said upper and lower concrete pile sections being disposed in substantial vertical end-to-end relation one to the other with the opposing plates of said pile sections butting one another, cooperating means carried by said butting plates for axially aligning said upper and lower pile sections including a surface of revolution symmetrical about the longitudinal axis of said upper pile section and projecting downwardly from said upper plate, and a surface of revolution symmetrical about the longitudinal axis of said lower pile section and recessed inwardly from said lower plate, said upper and lower surfaces of revolution comprising respective complementary convex and concave portions of said butting plates, said downwardly projecting convex surface being received in said concave surface when said first and second pile sections lie in axially aligned butting relation one to the other, means for securing said first and second pile sections in end to end axially aligned butting relation one to the other, said upper pile section having a plate disposed at its upper end and lying substantially normal to the longitudinal axis thereof, said latter plate having a plurality of openings for receiving the corresponding ends of said rods, and means for securing the ends of said rods within the openings of said plates, said rod ends of said upper and lower pile sections being disposed partially within the openings of the associated plates, said rod ends being welded about said rods in the inner face portions of the plates about the associated openings and about the sidewalls of said openings and the end faces of the associated rods.

2. A pile construction comprising upper and lower concrete pile sections each having a plurality of laterally spaced, longitudinally extending reinforcing rods, a pair of plates disposed at opposite ends of said upper pile section substantially normal to the longitudinal axis thereof and having a plurality of openings for receiving the corresponding ends of the rods associated with said upper pile section, a plate disposed at t8e upper end of said lower pile section substantially normal to the longitudinal axis thereof and having a plurality of openings for receiving the upper ends of the rods associated with said lower pile section, means for securing said rod ends to said plates, said rod ends being disposed partially within the openings of the associated plates and being welded exteriorly about the rods and the inner face portions of the associated plates about the openings thereof and exteriorly about the sidewalls of said openings and the end faces of said rods, said upper and lower concrete pile sections being disposed in substantially vertical end-to-end relation one to the other with opposing plates of said pile sections butting one another cooperating means carried by said butting plates for axially aligning said upper and lower pile sections including a surface of revolution symmetrical about the longitudinal axis of said upper pile section and projecting downwardly from said upper plate, and a surface of revolution symmetrical about the longitudinal axis of said lower pile section and recessed inwardly from said lower plate, said upper and lower surfaces of revolution comprising respective complementary convex and concave portions of said butting plates, said downwardly projecting convex surface being received in said concave recess when said first and second pile sections lie in axially aligned butting relation one to the other, and means for securing said first and second pile sections in end-to-end axially aligned butting relation one to the other.

3. A pile construction according to claim 2 wherein said butting plates have beveled lateral edges, said securing means for said butting plates including welding about the beveled edges thereof.