indentations 50 may instead be orifices (not shown) in the rod 3, typically towards the outer surface of the rod 3 and eccentric from the longitudinal axis of the rod 3. In this coupling embodiment, the deformation means 6, (shown as pins 6) may be driven between the sleeve 2 and rod 3 guided via the grooves 5/indentations 50 thereby causing interference when a drawing force is applied on the rod 3 attempting to draw the rod 3 from the sleeve 2. As shown in at least Figure 21, the resulting opening presented to the deformation means or pins 6 may be approximately the same diameter as the pins 6 although the diameter may be larger, smaller or variable along the pin 6 length (not shown) as it travels between the sleeve 2 and elongated element 3. There may for example be no deformation along the pin 6 length in this embodiment although this could be tailored to suit – for example by having a level of deformation at some point along the pin 6 length, if only to help retain the pin 6 in a coupled arrangement. Adhesives, packing or other methods (not shown) may be used to cause retention/deformation beyond just using the sleeve 2 and/or elongated element 3.

Applications

The coupler device defined above has the potential to couple a sleeve 2 to an elongated element 3 with a high degree of force such that the material properties of the elongated element 3 can also be matched. This will allow the coupled elongated element to undergo high levels of plastic deformation, with limited variation in performance when compared to the performance of the elongated element alone. The sleeve 2 that is coupled has the potential to take varying shapes and have varying applications. The sleeve 2 may be double ended and therefore used to couple two elongated elements 3 together in a relatively axial manner. Equally the sleeves 2 may accept more than two connecting elongated elements 3, with the elongated elements 3 joining in a non-axial manner. Figure 22 for example illustrates a perspective view of a footplate type connector embodiment, the sleeve 2 coupling an elongated rod 3 to a foot plate 300, the foot plate 300 having an elongated rod (not shown) welded to the footplate 300. Figure 23 illustrates a perspective view of a junction showing how the sleeve 2 can be used to link together multiple elongated elements 3.

The sleeve 2 may also only join to a single elongated element 3 with another form of detail 9 or connection type located on the sleeve 2. Once such connection type 9 may be a detail that allows two or more such connection types to join when axially misaligned by having tolerance for misalignment in the three separate coordinates (x, y, z) as well as an angular misalignment. This connection type may utilise a detail 9 with a curvilinear surface that can be adjusted axially along the length of the connector and a third connecting elongated element 3 that joins across the two curvilinear surfaces when spaced the desired axial distance, one example being that shown in Figure 24. Alternatively, the third connecting elongated element 3 may be able to be adjusted axially so as

WHAT IS CLAIMED IS:

1. A reinforcing bar coupling ~~device~~ assembly comprising:

a tubular sleeve with an inner surface that encloses at least part of at least one reinforcing ~~rod~~ bar when ~~to be~~ coupled with the at least one reinforcing bar, the inner surface shape of the tubular sleeve generally matching that of the at least one reinforcing bar to be coupled; and

at least one pin having a body and two opposing ends fitted with interference between, and causing local ~~predominantly~~ plastic deformation about, at least part of the inner surface of the sleeve and ~~predominantly~~ local plastic deformation about, at least part of, an adjacent outer surface of the at least one reinforcing ~~rod~~bar, where at least part of the body of the at least one pin is in contact with at least part of the inner surface of the sleeve and the outer surface of the at least one reinforcing ~~rod~~bar when coupled with the at least one reinforcing bar and wherein local plastic deformation of the inner surface of the sleeve and the adjacent outer surface of the at least one reinforcing bar results in mechanical interlocking of the coupling assembly;

wherein the at least one pin is inserted tangentially and orthogonally to the longitudinal length of the reinforcing bar between the inner surface of the sleeve and the adjacent outer surface of the at least one reinforcing bar when coupled with the at least one reinforcing bar; and

wherein, when a tractive force is applied to the coupling assembly, the coupling assembly is configured so that reinforcing bar material piles up or shears before a pin.

2. The reinforcing bar coupling ~~device~~ assembly as claimed in claim 1 wherein pin embedment in the sleeve and reinforcing ~~rod~~ bar to pin diameter (PED ratio) is at least 15%.

3. The reinforcing bar coupling assembly ~~device~~ as claimed in claim 2 wherein the PED ratio is from 15 to 30%.

4. The reinforcing bar coupling assembly ~~device~~ as claimed in ~~any one of the above claims~~claim 1 wherein the pin, prior to coupling, has a generally straight elongated and slender form along its body and two opposing ends, one end being a leading end and a second end being a following end, the leading end entering between the sleeve and reinforcing ~~rod~~ bar ~~interface~~ first during fitting or coupling.

5. The reinforcing bar coupling ~~device~~ assembly as claimed in claim 4 wherein the following end comprises a head with a form that extends outwardly beyond the cross-section width of the pin body.

~~6. The reinforcing bar coupling device as claimed in claim 3 or claim 4 wherein the pin leading end has a contoured shape configured to affect the insertion performance of the pin into the sleeve and/or reinforcing rod.~~

~~7.~~6. The reinforcing bar coupling ~~device~~ assembly as claimed in ~~any one of~~ claim~~s~~ 4 ~~to 6~~ wherein the leading end of the at least one pin remains within the sleeve once fitted.

~~8.~~7. The reinforcing bar coupling ~~device~~ assembly as claimed in ~~any one of the above claims~~claim 1 wherein the local plastic deformation is generated on installation of the pin to between the sleeve and reinforcing ~~rod~~ bar via use of an impulse energy input to forcibly insert the pin ~~to be inserted into~~between at least part of the inner surface of the sleeve and~~/or an~~ the adjacent outer surface of the at least one reinforcing ~~rod~~bar.

~~9. The reinforcing bar coupling device as claimed in any one of the above claims wherein the at least one pin is provided with sufficient impulse energy during fitting with interference to travel at a velocity of at least 50 m/s at the moment of entry into the coupling device or a part thereof.~~

~~10.~~8. The reinforcing bar coupling ~~device~~ assembly as claimed in ~~any one of the above claims~~claim 1 wherein local plastic deformation occurs to the at least one pin during installation.

~~11.~~9. The reinforcing bar coupling ~~device~~ assembly as claimed in claim ~~10~~ 8 wherein the pin is configured to ~~bent~~bend during fitting.

~~12.~~10. The reinforcing bar coupling ~~device~~ assembly as claimed in ~~any one of the above claims~~claim 1 wherein the pin, when fitted, passes through at least one orifice extending from the exterior of the sleeve to at least one groove recessed into the sleeve inner surface; ~~.~~

~~13. The reinforcing bar coupling device as claimed in claim 12 wherein the at least one pin itself produces the form of all or part of~~ wherein the at least one orifice and/or at least one groove~~.~~

~~14. The reinforcing bar coupling device as claimed in claim 12 wherein the at least one orifice and/or at least one groove~~ is/are formed in part or in full before coupling and wherein the orifice is undersized relative to the pin size to ensure an interference fit of the pin into the orifice.

11. The reinforcing bar coupling assembly as claimed in claim 10 wherein the at least one pin itself produces the form of all or part of the at least one orifice and/or at least one groove.

12. The reinforcing bar coupling assembly as claimed in claim 10 wherein the at least one orifice and/or at least one groove is/are formed in part or in full before coupling and wherein the orifice is undersized relative to the pin size to ensure an interference fit of the pin into the orifice.

~~15.~~13. The reinforcing bar coupling ~~device~~ assembly as claimed in ~~any one of the above~~

claimsclaim 1 wherein a plurality of pins are inserted to couple the at least one reinforcing rod bar and sleeve.

16. The reinforcing bar coupling device as claimed in claim 15 wherein each of the pins is inserted tangentially and generally orthogonally to the longitudinal length of the reinforcing rod between the sleeve interior face and reinforcing rod.

17.14. The reinforcing bar coupling device assembly as claimed in any one of the above claimsclaim 1 wherein, during fitting of the pin, heat generated by friction during deformation causes the at least one pin to weld to at least a portion of the sleeve and/or at least one reinforcing rodbar.

18.15. The reinforcing bar coupling device assembly as claimed in any one of the above claimsclaim 1 wherein the sleeve is double ended and used to couple two reinforcing rods bars together in a substantially axial manner.

19.16. The reinforcing bar coupling device assembly as claimed in any one of claims 1 to 17 wherein the sleeve is shaped to couple a first reinforcing rod bar and at least one additional reinforcing rodbar, the rods bars joining in a non-axial manner.

20. The reinforcing bar coupling device as claimed in any one of claims 1 to 17 wherein the sleeve couples to a single reinforcing rod with another form of detail or connection type located on the sleeve.

17. The reinforcing bar coupling assembly as claimed in claim 1 wherein the sleeve and the at least one reinforcing bar are coaxially aligned when coupled together.

18. The reinforcing bar coupling assembly as claimed in claim 1 wherein the local plastic deformation is generated on installation of the pin to the sleeve and at least one reinforcing bar via use of continuous pressure to forcibly insert the pin into at least part of the inner surface of the sleeve and into the adjacent outer surface of the at

least one reinforcing bar.

19. The reinforcing bar coupling assembly as claimed in claim 18 wherein the continuous pressure is a press configured to press the at least one pin into at least part of the inner surface of the sleeve and the adjacent outer surface of the at least one reinforcing bar.

~~21.~~20. A coupler configured to couple together reinforcing bar ends, the coupler comprising:

a sleeve with an inner surface that encloses, coaxially, an end of a first reinforcing bar to be coupled and an end of a second reinforcing bar to be coupled;

an array of pins configured to mechanically interlock the sleeve and first and second reinforcing bar ends, the pins fitted, with interference, tangentially and generally orthogonally to the longitudinal length of the first and second reinforcing bar ends, between the sleeve inner surface and first and second reinforcing bar ends so that the pins in the array, on fitting, cause local~~, and predominantly~~ plastic deformation about~~,~~ part of an outer surface of the first or second reinforcing bar ends.

~~22.~~21. The coupler as claimed in claim ~~21~~ 20 wherein the array once fitted comprises a row of pins inserted on both sides of the first or second reinforcing bar ends.

~~23.~~22. The coupler as claimed in claim ~~22~~ 21 wherein pins in each row of the array once fitted are located perpendicularly opposite each other.

~~24.~~23. The coupler as claimed in claim ~~22~~ 21 wherein pins in each row of the array once fitted are perpendicularly offset from each other.

~~25.~~24. The coupler as claimed in ~~any one of claims 22 to 24~~claim 21 wherein the array once fitted comprises three or more pins in each row of the array.

~~26.~~25. The coupler as claimed in claim ~~21~~ 20 wherein, once the pin array is fitted, the first

reinforcing bar is mechanically interlocked by two rows of three or more pins and, wherein the second reinforcing bar end is also mechanically interlocked by two rows of three or more pins.

~~27.~~26. The coupler as claimed in ~~any one of the above claims~~claim 20 wherein, before and after pin insertion, the pins remain straight.

~~28.~~27. The coupler as claimed in ~~any one of the above claims~~claim 20 wherein, each pin in the array, prior to fitting, has a generally straight elongated and slender form along its body and two opposing ends, one end being a leading end and a second end being a following end, the leading end entering first between the sleeve and reinforcing bar end during fitting.

~~29.~~28. The coupler as claimed in claim ~~28~~ 27 wherein the leading ends of the pins in the array remain within the sleeve once the pins are fitted.

~~30.~~29. The coupler as claimed in ~~any one of the above claims~~claim 20, wherein each pin in the array once fitted, is embedded in the sleeve and/or reinforcing bar to a pin diameter (PED ratio) of at least 15%.

~~31.~~30. The coupler as claimed in ~~any one of the above claims~~claim 20 wherein the local plastic deformation is generated on fitting of the pins between the sleeve and reinforcing bar via use of continuous pressure to forcibly insert each pin in the array between the sleeve inner surface and an adjacent outer surface of the first or second reinforcing bar end.

~~32.~~31. The coupler as claimed in claim ~~31~~ 30 wherein the continuous pressure is a press configured to press fit one or more pins between the inner surface of the sleeve and an adjacent outer surface of the first or second reinforcing bar ends.

~~33.~~32. The coupler as claimed in ~~any one of the above claims~~claim 20 wherein each pin,

when fitted, passes through at least one orifice on the exterior of the sleeve to at least one groove recessed into the sleeve inner surface, wherein the at least one orifice and/or at least one groove is/are formed in part or in full before coupling and wherein the orifice is undersized relative to the pin size to ensure an interference fit of the pin into the orifice.

~~34.~~33. The coupler as claimed in ~~any one of the above claims~~claim 20 wherein, the pins in the array, on fitting, also cause local, and predominantly plastic deformation, about part of the inner surface of the sleeve.

~~35.~~34. A method of coupling a first and second reinforcing bar, the method comprising the steps of:

providing a tubular sleeve having an inner surface that encloses at least part of at least one reinforcing bar when coupled with the at least one reinforcing bar, the inner surface shape of the tubular sleeve generally matching that of the at least one reinforcing bar to be coupled;

inserting an end of a first reinforcing bar to be coupled and an end of a second reinforcing bar to be coupled, into the sleeve, the first and second reinforcing bar ends being coaxially aligned; and

fitting an array of pins, with interference, tangentially and generally orthogonally to the longitudinal length of the first and second reinforcing bars, between the sleeve interior face and reinforcing bar end, so that the pins in the array cause local~~, and predominantly~~ plastic deformation about part of an outer surface of the first or second reinforcing bar, the pin array mechanically interlocking the sleeve and first and second reinforcing bar ends together.

~~36.~~35. The method as claimed in claim ~~35~~ 34 wherein the at least one pin is fitted with interference by applying a force to the pin by continuous pressure.

~~37.~~36. The method as claimed in claim 35 wherein the continuous pressure is a press configured to press one or more pins in the array between part of the inner surface

of the sleeve and into an adjacent outer surface of the first or second reinforcing bar.

~~38.~~37. The method as claimed in claim 36 wherein, multiple pins in the array are pressed during fitting.

~~39.~~38. The method as claimed in ~~any one of claims 35 to 38~~claim 34 wherein the pins in the array on fitting, also cause local, and predominantly plastic deformation, about part of the inner surface of the sleeve.

39. The reinforcing bar coupling assembly as claimed in claim 1 wherein adhesive is located between the inner surface of the tubular sleeve and the outer surface of the at least one reinforcing bar, the adhesive fusing and/or bonding the at least one pin and either, or both, the inner surface of the sleeve, or the outer surface of the at least one reinforcing bar.

40. The reinforcing bar coupling assembly as claimed in claim 39 wherein the adhesive is selected from: chemical adhesive, flux, metal plating, alloying elements, and chemical bonding.

41. The reinforcing bar coupling assembly as claimed in claim 1 wherein the at least one pin and tubular sleeve inner surface and/or at least one reinforcing bar outer surface are configured to provide a camming action of the at least one pin relative to the sleeve inner surface and/or at least one reinforcing bar outer surface, as axial displacement occurs between the at least one reinforcing bar and sleeve during axial loading of the reinforcing bar coupling assembly.

42. The reinforcing bar coupling assembly as claimed in claim 41 wherein the camming action increases interference between the at least one pin and the at least one reinforcing bar.

43. The reinforcing bar coupling assembly as claimed in claim 41 wherein the camming action decreases interference between the at least one pin and the at least one reinforcing bar.

44. The reinforcing bar coupling assembly as claimed in claim 41 wherein the camming action results in rotation of the at least one pin on application of an axial force, embedding an edge of the at least one pin further into the at least one reinforcing bar.

45. The coupler as claimed in claim 20 wherein adhesive is located between the inner surface of the sleeve and the outer surface of the at least one reinforcing bar, the adhesive fusing and/or bonding the at least one pin and either, or both, the inner surface of the sleeve, or the outer surface of the at least one reinforcing bar.

46. The coupler as claimed in claim 45 wherein the adhesive is present in the sleeve prior to fitment of the at least one reinforcing bar into the sleeve.

47. The coupler as claimed in claim 45 wherein the adhesive is applied between the sleeve and the at least one reinforcing bar after fitment of the at least one reinforcing bar into the sleeve.

48. The coupler as claimed in claim 20 wherein the at least one pin and sleeve inner surface and/or at least one reinforcing bar outer surface are configured to provide a camming action of the at least one pin relative to the sleeve inner surface and/or at least one reinforcing bar outer surface, as axial displacement occurs between the at least one reinforcing bar and sleeve during axial loading of the reinforcing bar coupling assembly.

49. The coupler as claimed in claim 48 wherein the camming action increases interference between the at least one pin and the at least one reinforcing bar.

50. The coupler as claimed in claim 48 wherein the camming action decreases interference between the at least one pin and the at least one reinforcing bar.

51. The coupler as claimed in claim 48 wherein the camming action results in rotation of the at least one pin on application of an axial force, embedding an edge of the at least one pin further into the at least one reinforcing bar.

52. The coupler as claimed in claim 48 wherein at least one pin in the array, prior to fitting, has a generally straight elongated and slender form along its body and two opposing ends and, at least one further pin in the array, prior to fitting, has a shape configured to provide a camming action.

53. A method of coupling a reinforcing bar to a coupler, the method comprising the steps of:

providing a coupler in the form of a sleeve having an inner surface;

inserting an end of a reinforcing bar to be coupled into the sleeve, the reinforcing bar end being coaxially aligned with a longitudinal axis of the coupler sleeve; and

fitting an array of pins, with interference, tangentially and generally orthogonally to the longitudinal length of the reinforcing bar, between the sleeve interior face and reinforcing bar end, so that the pins in the array cause local-plastic deformation about part of an outer surface of the reinforcing bar, the pin array mechanically interlocking the sleeve and reinforcing bar end together.

54. The method as claimed in claim 53 wherein prior to fitment of the at least one reinforcing bar into the sleeve, adhesive is located between the inner surface of the sleeve and the outer surface of the at least one reinforcing bar, the adhesive configured to fuse and/or bond the at least one pin and either, or both, the inner surface of the sleeve, or the outer surface of the at least one reinforcing bar.

55. The method as claimed in claim 53 wherein the at least one pin and sleeve inner

surface and/or at least one reinforcing bar outer surface are configured to provide a camming action of the at least one pin relative to the sleeve inner surface and/or at least one reinforcing bar outer surface, as axial displacement occurs between the at least one reinforcing bar and sleeve during axial loading of the reinforcing bar coupling assembly.