SUMMARY OF THE INVENTION

According to the present invention, there is provided a generally cylindrical element adapted for immersion in a body of water, the generally cylindrical element having an outer surface arranged, in use, to be in contact with the water, the outer surface comprising:-

at least two rows of repeating shapes provided thereon,

each row of repeating shapes being separated from each adjacent row by a groove arrangement and each shape within a row being separated from adjacent shapes by at least one groove;

wherein the shapes comprise six sides to form a hexagon shape such that the outer surface of the generally cylindrical element reduces Vortex Induced Vibration (VIV) and/or drag acting upon the generally cylindrical element.

Preferably, each of the repeating shapes within each row is identical. This has the advantage of maximising the number of shapes within each row.

Preferably, each row provided on the outer surface comprises identical repeating shapes to the shapes of each other row, such that all of the shapes provided on the outer surface are identical.

The shapes ~~may be triangles, squares, rectangles or pentagons but most preferably the shapes are~~ being hexagonal ~~. This~~ provides the advantage of maximising the total number of shapes for a given surface area provided on the outer surface. Most preferably, the said given surface area comprises a hexagonal tessellation. This provides the further advantage that the hexagonal patterns produce a more favourable flow pattern which improves the VIV suppression efficiency; there are several reasons for this but one of the main or most important reasons is that the hexagonal patterns and surrounding groove arrangement provide a plurality of flow separation points whilst minimising drag on the generally cylindrical element.

CLAIMS

1. A generally cylindrical element adapted for immersion in a body of water, the generally cylindrical element having an outer surface arranged, in use, to be in contact with the water, the outer surface comprising:

at least two rows of repeating shapes provided thereon,

each row of repeating shapes being separated from each adjacent row by a groove arrangement and each shape within a row being separated from adjacent shapes by at least one groove;

wherein the shapes comprise six sides to form a hexagon shape such that the outer surface of the generally cylindrical element reduces Vortex Induced Vibration (VIV) and/or drag acting upon the generally cylindrical element.

2. A generally cylindrical element as claimed in claim 1, wherein each of the repeating hexagon shapes within each row is identical.

3. A generally cylindrical element as claimed in claim 1 or claim 2, wherein each row provided on the outer surface comprises identical repeating hexagon shapes to the hexagon shapes of each other row, such that all of the hexagon shapes provided on the outer surface are identical.

4. A generally cylindrical element as claimed in claims 1-3, wherein repeating hexagon shapes are arranged on the outer surface in a tessellation.

5. A generally cylindrical element as claimed in any preceding claim, wherein the outer surface of the cylindrical element comprises a hexagonal tessellation in which each three adjacent hexagon shapes meet at adjoining vertices and the rest of the hexagon shapes repeat that arrangement across the outer surface of the cylindrical element.

6. A generally cylindrical element as claimed in claims 1-5, wherein at least one vertex between two adjacent sides of each repeating hexagon shape comprises a radius.

7. A generally cylindrical element as claimed in claims 1-6, wherein each repeating hexagon shape projects from the outer surface of the generally cylindrical element due to the groove arrangements.

8. A generally cylindrical element as claimed in claims 1-7, wherein the generally cylindrical element is adapted to be placed around a substantially cylindrical structure which, in use, is located in the body of water.

9. A generally cylindrical element as claimed in claim 8, wherein the generally cylindrical element is formed of two or more sections that when brought together envelope the substantially cylindrical structure.

10. A generally cylindrical element as claimed in claim 9, wherein the generally cylindrical element is C-shaped in cross section and comprises a slit formed along the whole length at one side such that it can be slid over the length of the generally cylindrical structure.

11. A generally cylindrical element as claimed in claims 1-7, wherein the generally cylindrical element is formed integrally with a substantially cylindrical structure which, in use, is located in the body of water.

12. A generally cylindrical element as claimed in claims 1-11, wherein the groove arrangement comprises angled side faces.

13. A generally cylindrical element as claimed in claim 12, wherein the angled side faces are angled between 40 to 80 degrees relative to the radius of the generally cylindrical element.

14. A generally cylindrical element as claimed in claims 1-11, wherein the groove arrangement comprises a semi-circular profile.

15. A generally cylindrical element as claimed in claim 14, wherein the width of the groove arrangement is within the range of 0.50 to 0.60 times the outermost radius of the generally cylindrical element.

16. A generally cylindrical element as claimed in claims 1-15, wherein the groove arrangement for each row of repeating hexagon shapes comprises an upper groove and a lower groove, where each of the upper and lower grooves encircles the full 360 degree circumference of the generally cylindrical element such that each of said upper and lower grooves is continuous around the generally cylindrical element.

17. A generally cylindrical element as claimed in claims 1-16, wherein the groove arrangement provides at least one separated path for a flow of water to follow around the circumference of the generally cylindrical element, such that water flowing within the groove arrangement meets at least one flow separation point.

18. A generally cylindrical element as claimed in claim 17, wherein the flow separation point comprises a vertex of a hexagon shape where two sides of the hexagon shape meet.

19. A generally cylindrical element as claimed in claim 17 or claim 18, wherein the flow separation point comprises a side of the hexagon shape.

20. A generally cylindrical element as claimed in claims 17-19, wherein when the water flowing within the groove arrangement meets a flow separation point, the direction of at least a portion of the water flow is changed by less than 90°.

21. A generally cylindrical element as claimed in any preceding claim, provided in multiple part circular shells which when brought together envelope the substantially cylindrical structure located in the body of water and which typically comprise buoyancy to aid floatation of the substantially cylindrical structure located in the body of water.

22. A generally cylindrical element as claimed in claim 21, further comprising stacking flats to permit individual shells to be stacked one on top of another.

23. A generally cylindrical element as claimed in claims 21 or 22, further comprising strap and/or bolt holes to assist coupling the shells to one another around a substantially cylindrical structure which, in use, is located in a body of water.

24. A generally cylindrical element as claimed in claims 21 or 22, further comprising strap and/or lifting holes to assist transportation of the generally cylindrical element or shells thereof.

25. A generally cylindrical element as claimed in any of claims 1 to 20, further comprising a subsea conduit, wherein the inner surface/throughbore of the generally cylindrical element is bonded directly to the outer surface of the subsea conduit.

26. A generally cylindrical element as claimed in claim 25, wherein a protective coating layer is provided between the inner surface/throughbore of the generally cylindrical element and the outer surface of the subsea conduit in a co-axial manner.

27. A generally cylindrical element as claimed in claim 26, wherein the protective coating layer is bonded to the respective surface on each of its outer and inner surfaces.

28. A generally cylindrical element as claimed in any preceding claim, wherein the said groove arrangements comprise a groove having a depth of profile = 0.01 to 0.1 times the outer diameter (OD) of the generally cylindrical element.

29. A generally cylindrical element as claimed in claim 28, wherein the said groove arrangements comprise a groove having a depth of profile =

approximately 0.05 times the outermost diameter (OD) of the generally cylindrical element.