

AN ARTICLE OF JOINT STRUCTURAL ELEMENTS

The invention relates to an article of joint structural elements.

5 A variety of techniques exists for joining elements of structures, such as containers, where the principal elements are in sheet form. A sheet is an element of a significantly stiff and elastic material having one size, namely its thickness, which is
10 considerably smaller than its other sizes, e.g. the skin of an aircraft wing or a plastics corrugated panel of a car-port roof.

Joining techniques have evolved which fall into two classes: joints which can be assembled and dismantled without disruption of the materials of the
15 structural elements and the joining elements, and joints which cannot. This is equally true when joining one sheet element to another sheet element or when joining a sheet element to another structural element, e.g. a beam, truss or bracket.

20 In the first class are the commonly used fastening methods, such as pinning and bolting, where loads are transferred from the sheet element to another structural element (sheet element or otherwise) through the fastener as shear, tension and
25 bending. These methods have the major disadvantage that high stresses (intensities of load) are generated at the interfaces of the sheet and the fasteners in comparison to the stresses in the remainder of the sheet. This in turn requires that
30 the structure be heavier than desired, because the thickness of the sheet is often determined by these stress levels at the fastener and/or because more fasteners and larger attachment flanges are required at the joints.

35 The invention aims to avoid unnecessary

weight by utilizing more fully the total strength of the sheet elements throughout and the need for holes in the sheet possessing high accuracies of form and position, and to devise a joint which can be readily dismantled and re-assembled without loss of joint efficiency while considerably reducing the number of fasteners used.

The second class of joint has a number of disadvantages well known to the men skilled in the art. Because the invention belongs to the first class the second class will not be further discussed.

The invention will also be compared to the prior art for the assembly of structural elements such as extruded and rolled products, having constant cross-sections throughout their lengths.

The prior art includes interlocking joints which lock together as a jigsaw puzzle, in that one element possesses a feature of its geometric cross-section which fits into a feature of another element. Such joints are generally of two types:

(a) loose fitting, where the joint can be readily dismantled and re-assembled but requires significant clearances between the elements. The clearance must be closed by movement of at least one element before loads can be transferred or reversed, producing "rattle", wear and fatigue. Such joints are not normally satisfactory under conditions of vibration, which cause so-called fretting, and do not give the most efficient joints. Typical examples are the slatted roller blind doors on vans and some cabinets.

(b) tight fitting, where the clearances allow initial assembly to take place easily and are sufficiently small to prevent movement, rattling and wear. These

5 joints have the disadvantage that dismantling can be very difficult after they have been assembled for some time, e.g. due to corrosion or ingress of dust and dirt. Typical examples are modern aluminium alloy window frame assemblies.

The invention aims to adopt the benefits of interlocking joints for structural sheet elements while avoiding the disadvantages experienced with solid elements possessing constant cross-sections.

10 The invention provides an article comprising two sheets and a structural element, wherein each of said sheets has an elongate portion along which it is joined to said element, that portion being shaped to have an elongate,
15 substantially trough-shaped part substantially as long as said portion, and the structural element has for the trough-shaped part of each said sheet a respective complementarily shaped profiled part substantially as long as, and interengaged with, the
20 trough-shaped part of the associated sheet, an intermediate portion interconnecting the profiled parts, the intermediate portion being provided with a plurality of holes, the joint including removable clamping means which, when the interengaged parts are
25 subjected to forces acting substantially transversely thereto, take up components of said forces which act in a direction tending to disengage said parts, the clamping means including a plurality of fasteners passing through at least some of said holes, each
30 fastener having a first closing part and a second closing part between which are situated the sheets and the structural element, the trough-shaped parts and the profiled parts being so shaped that one of the parts is snugly interengageable with the
35 associated part such that, where the parts are in

contact with each other, loads transmitted, in use, between the sheet and the element are transmitted substantially by compression, that the parts are interengageable by simple insertion (as hereinafter defined) of one of the parts into the other, and that the clamping means are, in use, stressed substantially only in tension.

The invention also provides an article comprising a sheet and a structural element, wherein the sheet has an elongate portion along which it is joined to said element, said portion being shaped to have two elongate spaced-apart substantially trough-shaped parts substantially as long as said portion, and the structural element has two complementarily shaped spaced-apart profiled parts substantially as long as and interengaged with the trough-shaped parts, the sheet having between the two trough-shaped parts a first portion provided with a plurality of first holes, and the structural element having between the two profiled parts a second portion provided with a plurality of second holes, at least some first holes communicating with at least some second holes, the joint including removable clamping means which, when the interengaged parts are subjected to forces acting substantially transversely thereto, take up components of said forces which act in a direction tending to disengage said parts, the clamping means including a plurality of fasteners passing through at least some of said communicating holes, each fastener having a first closing part and a second closing part between which are situated the sheet and the structural element, the trough-shaped parts and the profiled parts being so shaped that one of the parts is snugly interengageable with the associated part such that, where the parts are in

contact with each other, loads transmitted, in use, between the sheet and the element are transmitted substantially by compression, that the parts are interengageable by simple insertion (as hereinafter defined) of one of the parts into the other, and that the clamping means are, in use, stressed substantially only in tension.

The term "simple insertion" as used herein is intended to mean "insertion not requiring relative displacement of the parts in their longitudinal direction, or their interengagement by hooking one into the other by rotation of one relative to the other, or deformation, whether permanent or temporary, of any of said parts."

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

Figure 1 shows a first joint between two sheets and a retaining profiled element using a bearing plate,

Figure 2 shows a second joint of two sheets (with the second sheet omitted) with a retaining profiled element, in which the sheets and the element have mating recesses,

Figure 3 shows a third joint of two sheets (with the second sheet omitted) with a retaining profiled element, in which the sheets have dimples mating with holes in the element,

Figure 4 shows a fourth joint between a sheet and a structural element using a bearing element,

Figure 5 shows a fifth joint between two sheets and a structural element using a bearing element, and

Figure 6 shows a sixth joint between two

sheets and a structural element using two bearing elements.

Figure 1 illustrates a joint between a roof sheet 91 and a side sheet 91', with vertical loads A and side loads B acting. The smallest loads are those in the directions C and D. In these examples both the sheets 91 and 91' fit into a retaining profiled element 92 shaped to match the sheets 91 and 91' at the joint interfaces. A bearing plate 94 fits between the sheets 91 and 91' at the joint and is clamped by a two-part fastener 95,96. An additional sealing element 97 of a compressible material, such as rubber, may be introduced as shown to prevent the ingress of e.g. moisture through the holes through which passes the shank of the fastener 95,96. The joint can be dismantled by cutting the fasteners, removing the bearing plate 94 and then springing the two sheets 91,91' and the element 92 apart. Reassembly is the reverse of dismantling. Example of the embodiment combining, in general, the features of the joint illustrated in Figure 1 will now be described in connection with Figure 2.

Figure 2 illustrates a joint of two sheets, namely of a sheet 111 and a sheet (not shown) which is a mirror image of the sheet 111, by means of a retaining profiled element 112. The sheet 111 has on one face of one of its margin portions substantially rectangular depressions 114 and 115, which make on the opposite face of that portion similarly shaped projections which fit, respectively, into substantially rectangular recesses 116 and 117 in a portion of the profile element 112 when the joint is assembled, to transfer shear loads A and A'.

Figure 3 shows a joint which is basically of the same type as the joint illustrated in Figure

2, except that the sheet 121 is provided with dimples 124 and 125 which mate with holes 126 and 127 in the retaining profiled element 122 when the joint is assembled, to transfer the shear loads A and A'.

5 The invention is not restricted to straight joints but may be applied to other joint shapes, e.g. a corner joint between a vertical part-cylindrical sheet and a horizontal sheet extending substantially perpendicularly thereto.

10 Figure 4 illustrates a fourth embodiment in which the offset of the mating curved shapes of the sheet 151 is reduced to the minimum whilst a sufficient shear area across the sheet at the section X-X is still maintained for all angles θ to the
15 vertical from 0° to 90° to react the applied tension load A equivalent to the tensile load capacity of the sheet material. The sheet 151 is prevented from sliding out of engagement with the structural element 152 by providing a bearing element 153 which matches
20 the form of the sheet 151 at the mating surface. The joint is again provided with two-part tensile fasteners 155, 156 passing through clearance holes spaced along the joint, for which a straight portion 151d is provided in the sheet 151. Two trough-shaped
25 portions 151e and 151f are provided in the embodiment to allow for symmetry of the bearing element 153, giving a further advantage that if yielding of the sheet material commences at portion 151e, part of the load A can be reacted at portion 151f. Other
30 features and advantages are similar to those described earlier.

 Figure 5 illustrates a fifth embodiment, which is a practical embodiment of that shown in Figure 4 which shows a structural element 162
35 designed as a corner element and having two arms

which are substantially at right angles to each other. To each of the arms is connected one sheet 161,161', respectively, by means of a bearing element 163,163'. The two sheets 161,161' are connected to the structural element 162 in identical manner and consequently only the connection of the sheet 161 will be described for simplicity. The arm to which the sheet 161 is connected includes a hook-shaped portion 162a engaging with a complementarily shaped portion 163a on the bearing element 163 to give better clamping at the portion 161f of the sheet 161. The portion 163b of the bearing element 163 is provided to give increased bending stiffness to the element 163 and therefore better clamping at the portion 161e of the sheet 161.

Figure 6 is a sixth embodiment obtained by further development of the embodiment shown in Figure 1 for joining two sheets 171 and 171' to a structural element 172 which is a corner element. The element 172 is designed for the connection of the sheets 171 and 171' substantially at right angles to each other. It will be understood that it could be designed for the connection of the two sheet elements at a different angle. The sheets 171,171' are prevented from sliding out of engagement with the structural element 172 by a bearing element 173. As is apparent from Figure 6 each of the sheets 171,171' has a trough-shaped part snugly accommodated in a complementarily shaped profiled part in the structural element 172, and the bearing element 173 has for each of the sheets 171,171' a profiled part which engages into the trough-shaped parts of the respective sheets 171,171'. The joint is again provided with a two-part tensile fastener 175,176 which in this embodiment transmits the clamping load

to the joint through the bodies of the elements 172 and 173 allowing one row of fasteners to clamp two joints. Other features and advantages are similar to those described earlier.



CLAIMS

1. An article comprising two sheets and a structural element, wherein each of said sheets has an elongate portion along which it is joined to said element, that portion being shaped to have an elongate, substantially trough-shaped part substantially as long as said portion, and the structural element has for the trough-shaped part of each said sheet a respective complementarily shaped profiled part substantially as long as, and interengaged with, the trough-shaped part of the associated sheet, an intermediate portion interconnecting the profiled parts, the intermediate portion being provided with a plurality of holes, the joint including removable clamping means which, when the interengaged parts are subjected to forces acting substantially transversely thereto, take up components of said forces which act in a direction tending to disengage said parts, the clamping means including a plurality of fasteners passing through at least some of said holes, each fastener having a first closing part and a second closing part between which are situated the sheets and the structural element, the trough-shaped parts and the profiled parts being so shaped that one of the parts is snugly interengageable with the associated part such that, where the parts are in contact with each other, loads transmitted, in use, between the sheet and the element are transmitted substantially by compression, that the parts are interengageable by simple insertion (as hereinbefore defined) of one of the parts into the other, and that the clamping means are, in use, stressed substantially only in tension.
2. An article according to Claim 1, including a bearing element provided with holes, at least some



of the holes accommodating one said fastener, whereby the bearing element is held in firm contact with the sheets.

3. An article comprising two sheets and a structural element, constructed, arranged, and adapted to operate substantially as herein described with reference to, and as shown in, Figure 1, Figure 2, Figure 3, Figure 5 or Figure 6 of the accompanying drawings.

4. An article comprising a sheet and a structural element, wherein the sheet has an elongate portion along which it is joined to said element, said portion being shaped to have two elongate spaced-apart substantially trough-shaped parts substantially as long as said portion, and the structural element has two complementarily shaped spaced-apart profiled parts substantially as long as and interengaged with the trough-shaped parts, the sheet having between the two trough-shaped parts a first portion provided with a plurality of first holes, and the structural element having between the two profiled parts a second portion provided with a plurality of second holes, at least some first holes communicating with at least some second holes, the joint including removable clamping means which, when the interengaged parts are subjected to forces acting substantially transversely thereto, take up components of said forces which act in a direction tending to disengage said parts, the clamping means including a plurality of fasteners passing through at least some of said communicating holes, each fastener having a first closing part and a second closing part between which are situated the sheet and the structural element, the trough-shaped parts and the profiled parts being so shaped that one of the parts



is snugly interengageable with the associated part such that, where the parts are in contact with each other, loads transmitted, in use, between the sheet and the element are transmitted substantially by compression, that the parts are interengageable by simple insertion (as hereinbefore defined) of one of the parts into the other, and that the clamping means are, in use, stressed substantially only in tension.

5
10
15
20
25
5. An article according to Claim 4, including a bearing element which is provided with two spaced-apart second profiled parts matching the trough-shaped parts and with a plurality of third holes for the fasteners between the profiled parts, the sheet being sandwiched between the structural element and the bearing element, the two elements being held in firm connection with the sheet by said fasteners.

6. An article according to Claim 5, wherein one of said structural element and bearing element has a hook-shaped portion and the other of said bearing element and structural element has an anchoring portion interengageable with the hook-shaped portion to provide additional resistance to transverse forces and additional clamping between the structural element and the bearing element.

7. An article comprising a sheet and a structural element, constructed, arranged and adapted to operate substantially as herein described with reference to, and as shown in Figures 4 and 5 of the accompanying drawings.

The text of the specification has been reproduced by photocopying the applicants original typescript. It may contain a few amendments which are difficult to read. The original typescript containing these amendments may be inspected on the premises of the Patent Office