US 20030207116A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2003/0207116 A1**

Franken et al. (43) **Pub. Date: Nov. 6, 2003**

(54) **SANDWICH ELEMENTS AND THE USE THEREOF**

(76) Inventors: **Klaus Franken**, Bergisch Gladbach (DE); **Reiner Paul**, Leichlingen (DE)

Correspondence Address:
BAYER POLYMERS LLC
100 BAYER ROAD
PITTSBURGH, PA 15205 (US)

(21) Appl. No.: **10/420,199**

(22) Filed: **Apr. 22, 2003**

(30) **Foreign Application Priority Data**

May 2, 2002 (DE) 10219711.3

Publication Classification

(51) **Int. Cl.**[7] **D04H 1/00**

(52) **U.S. Cl.** **428/411.1**

(57) **ABSTRACT**

The present invention relates to sandwich elements with at least one predetermined breaking-point at which the sandwich element breaks in the event of an impact. The present invention further relates to the use of such sandwich elements, particularly in the automotive field.

SANDWICH ELEMENTS AND THE USE THEREOF

FIELD OF THE INVENTION

[0001] The invention relates to sandwich elements with at least one predetermined breaking-point at which the sandwich element breaks in the event of an impact and also to their use in the automotive field.

BACKGROUND OF THE INVENTION

[0002] Sandwich elements can be employed, for example, in the automotive field as roof, bonnet, tailgate, door or floor-panel modules and also as load floors, rear parcel shelves or interior-trim components; an advantage in this connection is their high flexural rigidity with, at the same time, low area weight in comparison with structural elements of massive construction. In particular, structural elements that extend predominantly in a plane display high rigidity and strength values when loaded in that plane. However, in many structural elements these high strength values in the plane are disadvantageous.

[0003] For example, in the case of load floors of automobiles it can happen that the load floors do not break in the event of a rear-end crash but pass on the energy of the crash to the passenger compartment and the occupants. This entails a high potential exposure to danger.

[0004] The load floors currently on the market are therefore provided, if necessary, with notches or slits. Such predetermined breaking-points weaken the load floors in the event of an accident. However, at the same time the load floors also always lose a large proportion of their flexural rigidity and flexural strength and diminish the working load.

[0005] Designs with articulations (hinges) in the load floors, at which the load floor collapses in the event of a crash, are possible but are technically very elaborate.

[0006] Split load floors also exist. In this case it is disadvantageous that under unfavorable loading conditions the entire load rests on only one subsegment. This requires an additional high flexural rigidity of the individual segments.

[0007] Furthermore, by virtue of special structural bearing elements it can be ensured that the load floors rotate into a harmless position in the event of an accident. But such very elaborate measures cannot be implemented in every vehicle.

SUMMARY OF THE INVENTION

[0008] The present invention therefore provides constructional elements that exhibit, on the one hand, a low weight and, on the other hand, a high flexural rigidity and flexural strength and that, in addition, in the event of an accident (a crash, in particular a rear-end crash) do not transmit the energy of the crash into the passenger cell and hence endanger the occupants.

[0009] This is achieved by the introduction of at least one predetermined breaking-point into a sandwich element, whereby in the event of a rear-end collision the sandwich element breaks at the predetermined breaking-point, so that the energy of the crash is not transmitted (reduced strength of the sandwich element in the plane), whereas the flexural strength and flexural rigidity under working load remain unchanged.

[0010] These and other advantages and benefits of the present invention will be apparent from the Detailed Description of the Invention herein below.

DETAILED DESCRIPTION OF THE INVENTION

[0011] The present invention will now be described for purposes of illustration and not limitation.

[0012] The present invention provides a sandwich element with at least one predetermined breaking-point, the sandwich element made of

[0013] a) a core layer, preferably constructed from at least one ply, and

[0014] b) two exterior outer layers firmly connected to the core layer, which are preferably each constructed from at least one ply,

[0015] c) optionally, one or more adhesive layers disposed between the core layer and the exterior layers,

[0016] wherein at least one delamination means is included in at least a portion of the sandwich element on a first (tension) side of the sandwich element, and wherein the delamination means is disposed between the exterior layer located on the first (tension) side and the core layer or contained in the outermost third of the core layer on the first (tension) side of the sandwich element.

[0017] The first (tension) side is that side of the sandwich element that is subjected to tensile stresses in the event of a flexural load.

[0018] For the exterior layers in the present invention, use may be made of fibrous materials that are interspersed with plastics (such as, for example, polycarbonates, polyamides, polyurethanes, polyesters, polypropylene, polyethylene, polyvinyl chloride, polystyrene, polymethyl methacrylate, acrylonitrile/butadiene/styrene copolymers and blends thereof, epoxy resins, in particular polyurethane resin), such as glass-fiber mats, glass-fiber fleeces, glass-fiber random layers, glass-fiber cloth, cut or ground glass fibers and mineral fibers, natural-fiber mats, natural-fiber knitted fabric, cut natural fibers and also fibrous mats, fibrous fleeces and fibrous knitted fabric based on polymer fibers, carbon fibers or aramide fibers and also mixtures thereof. Plastics such as, for example, polycarbonates, polyamides, polyurethanes, polyesters, polyethers, copolymers, polypropylene, polyethylene, polyvinyl chloride, polystyrene, polymethyl methacrylate, acrylonitrile/butadiene/styrene copolymers and blends thereof can also be employed. Furthermore, metal sheets, plastic sheets, wood panels or wood veneers can be employed. Glass-fiber mats with polyurethane resin applied to them preferably find application in the present invention.

[0019] As a core layer, thermoformable and also thermosetting polyurethane and thermoplastic foamed materials, paper honeycombs, metal honeycombs or plastic honeycombs with honeycomb or corrugated structure may preferably be employed in the present invention.

[0020] As a delamination means, means having a decoupling effect (loosening the adhesion between exterior layer and core layer or weakening the core layer on the tension side), which are introduced either (a) in situ in the course of manufacture of the sandwich elements or (b) subsequently, may preferably be disposed between the exterior layers and the core layer.

[0021] Suitable materials in case (a) include, but are not limited to, paper, cardboard, plastic foils and sheets or sheet-metal foils and plates, textile, plastic or metal foils provided with adhesive layers on one side, wood panels or wood veneers, impermeable textiles or naturally or synthetically based woven fabrics as well as solid or liquid films acting as separating agents as well as adhesive-free or coupling-agent-free zones. Where use is made of adhesive layers, an adhesive-free zone, for example, may act as delamination means. An adhesive-free zone or a zone with low adhesion or without adhesion can be produced by a delamination means which was inserted during the manufacture of the sandwich element being removed.

[0022] Suitable in case (b) are subsequent, mechanical or thermal, locally limited separation, such as sawing, cutting, splitting or lasing, of the core layer and of the exterior layer on the tension side, so that a zone without adhesion is formed.

[0023] The decoupling is more preferably obtained by means of delamination means that are described in case (a).

[0024] The sandwich elements according to the present invention may find particular application in the automotive field as roof modules, bonnets, tailgate modules, door modules or floor-panel modules, more particularly as load floors, rear parcel shelves or interior-trim components.

[0025] The flexural strength is the limit of the flexural load, the exceeding of which results in failure of the structural element.

[0026] The flexural rigidity is the resistance of a structural element to flexure.

[0027] The invention will be elucidated in more detail on the basis of the following Examples.

EXAMPLES

[0028] In Comparative Example 1, a compression test was carried out in the plane of the sheet (crash direction) on samples without predetermined breaking-point, and in Example 2, on samples with predetermined breaking-points according to the invention. In Comparative Example 3, the flexural rigidity and flexural strength were determined on samples without predetermined breaking-point, and in Example 4, on samples with predetermined breaking-point according to the invention. Examples 5 and 6 show, on the basis of compression tests, how the breaking behavior can be controlled by modification of the type and geometry of the predetermined breaking-point according to the invention.

[0029] Initial Materials:

Polyol 1:	polyether polyol with an OH-value of 865, prepared by addition of propylene oxide onto trimethylolpropane as initiator.
Polyol 2:	polyether polyol with an OH-value of 1000, prepared by addition of propylene oxide onto trimethylolpropane as initiator.

-continued

Polyol 3:	polyether polyol with an OH-value of 42, prepared by addition of 86% propylene oxide and 14% ethylene oxide onto propylene glycol as initiator.
Polyisocyanate:	polymeric MDI with an isocyanate content of 31.5 wt. % (DESMODUR 44V20L, Bayer AG).
Stabilizer:	silicone stabilizer POLYURAX SR242, Osi Crompton Witco Specialities, Frankfurt.
Catalyst:	amine catalyst THANCAT AN10, Air Products GmbH, Hattingen.
Dyestuff:	BAYDUR Schwarzpaste DN, Bayer AG, Leverkusen.

[0030] Polyurethane Formulation 1:

Polyol 1	30 parts by weight
Polyol 2	20 parts by weight
Polyol 3	33 parts by weight
catalyst	2.8 parts by weight
stabilizer	1.3 parts by weight
acetic acid	0.3 parts by weight
dyestuff	3.3 parts by weight
polyisocyanate	140 parts by weight

[0031] The polyol mixture formed from Polyols 1 to 3 has an average OH-value of 568 mg KOH/g.

Comparative Example 1

[0032] (Compression Test on Samples Without Predetermined Breaking-point)

[0033] Onto a flat core layer made of a paper honeycomb of corrugated-board type 5/5 having a thickness of 20 mm and an area weight of 1,600 g/m^2 there were placed on both sides chopped glass-fiber mats having an area weight of 450 g/m^2 which were treated at room temperature by spraying on 450 g/m^2 of polyurethane formulation 1. This sandwich element was introduced into a flat tool heated to 130° C. and subsequently press-molded to a thickness of 19.4 mm. After a pressing-time of 180 sec., the tool was opened and the finished sandwich element was taken out. The size of this sandwich element amounted to about 1,000 mm×1,000 mm.

[0034] Three rectangular samples having a size of 400 mm×180 mm (length×width) were sawn out of the sandwich element which was produced in this way, the longer edge of the sample being at right angles to the course of the paper corrugations of the core layer. These samples were subjected to pressure uniaxially over the front faces in a universal tension/compression testing machine at a speed of 5 mm/min. The compressive stress consequently acted in the plane of the sheet in the direction of the longer dimension of the sample. The forces resulting in failure of the samples amounted to 14,173 N, 14,093 N and 15,928 N (mean value: 14,731 N).

Example 2

[0035] (Compression Test on Samples With Predetermined Breaking-point)

[0036] A delamination means made of an aluminum strip coated with adhesive on one side, manufactured by Beiersdorf AG, brand TESA, designation TESAMETAL 4500, was applied onto a core layer as described above. The delamination means was cut to a width of 15 mm and a length of 1,000 mm and was stuck onto one side parallel to the course of the paper corrugations in the middle of the core layer. Then there were placed on both sides chopped glass-fiber mats having an area weight of 450 g/m^2 which were treated at room temperature by spraying on 450 g/m^2 of polyurethane formulation 1. This sandwich element was introduced into a flat tool heated to 130° C. and subsequently press-molded to a thickness of 19.4 mm. After a pressing-time of 180 sec., the tool was opened and the finished sandwich element was taken out. The size of this sandwich element amounted to about 1,000 mm×1,000 mm. Then three rectangular samples with a size of 400 mm×180 mm were sawn out of the sheet, the longer edge of the sample being at right angles to the course of the paper corrugations of the core layer. The samples were sawn out in such a way that the delamination means was located in the middle of the samples. With the exception of the delamination means, these samples were produced so as to be identical to those from Comparative Example 1.

[0037] The compression testing was effected in a manner analogous to Comparative Example 1. The forces (breaking-loads) resulting in failure of the samples amounted to 5,622 N, 5,106 N and 5,777 N (mean value: 5,502 N). By virtue of the predetermined breaking-point in Example 2, the mean value of the breaking-load in comparison with sandwich elements without predetermined breaking-point (Comparative Example 1) was reduced to 37%.

Comparative Example 3

[0038] (Flexural Test on Samples Without Predetermined Breaking-point)

[0039] Five samples each having a length of 240 mm and a width of 60 mm were taken from the sandwich element described in Comparative Example 1. The orientation of the corrugated honeycomb was at right angles to the length of the sample. The flexural test was carried out in accordance with DIN 53293. Effective flexural-rigidity values of 80.6×10^6 Nmm^2, 82.1×10^6 Nmm^2, 72.1×10^6 Nmm^2, 75.4×10^6 Nmm^2 and 77.5×10^6 Nmm^2 (mean value: 77.5×10^6 Nmm^2) were ascertained. The forces in the case of failure amounted to 853.6 N, 826.4 N, 828.7 N, 845.4 N and 820.6 N (mean value 834.9 N).

Example 4

[0040] (Flexural Test on Samples With Predetermined Breaking-point)

[0041] Five samples each having a length of 240 mm and a width of 60 mm were taken from the sandwich element described in Example 2. The orientation of the corrugated honeycomb was at right angles to the length of the sample, the delamination means was located in the middle of the sample. The flexural test was carried out in accordance with DIN 53293. The samples were inserted into the testing device in such a way that the delamination means was located on the tension side of the samples. Effective flexural-rigidity values of 84.3×10^6 Nmm^2, 76.1×10^6 Nmm^2, 74.6×10^6 Nmm^2, 79.2×10^6 Nmm^2 and 72.3×10^6 Nmm^2 (mean value: 77.3×10^6 Nmm^2) were ascertained. The forces in the case of failure amounted to 875.2 N, 864.8 N, 872.2 N, 849.1 N and 867.7 N (mean value 865.8 N).

[0042] In the case of an arrangement of the delamination means on the first (tension) side of the sandwich element, the effective flexural rigidity with and without delamination means did not change within the limits of the statistical variation of the measured values. The forces resulting in failure of the samples in the case with delamination means (Example 4) did not lie below the values for the case without delamination means (Comparative Example 3).

Example 5

[0043] (Compression Test on Samples With Predetermined Breaking-point)

[0044] In a manner analogous to Example 2, compression tests were carried out with the same delamination means (TESAMETAL 4500), this time cut to a width of 35 mm. The forces (breaking-loads) resulting in failure of the samples amounted to 1,838 N, 1,654 N and 1,735 N (mean value 1,742 N).

Example 6

[0045] (Compression Test on Samples With Predetermined Breaking-point)

[0046] In a manner analogous to Example 2, compression tests were carried out with another delamination means (adhesive tape manufactured by Beiersdorf AG, brand TESA, designation 4304; strip of paper coated with adhesive on one side). The delamination means was cut to a width of 35 mm. The forces (breaking-loads) resulting in failure of the samples amounted to 5,146 N, 5,374 N and 4,712 N (mean value 5,077 N).

[0047] Although the invention has been described in detail in the foregoing for the purpose of illustration, it is to be understood that such detail is solely for that purpose and that variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention except as it may be limited by the appended claims.

What is claimed is:

1. A sandwich element comprising:

a) a core layer; and

b) two exterior outer layers firmly connected to the core layer,

c) optionally, at least one adhesive layer disposed between the core layer and the exterior layers,

wherein a delamination means is included in at least a portion of the sandwich element on a first (tension) side of the sandwich element, and wherein the delamination means is disposed between the exterior layer located on the first (tension) side and the core layer or contained in the outermost third of the core layer on the first (tension) side of the sandwich element.

2. In a process of making one of a roof module, bonnet, tailgate module, door module, floor-panel module, load floor, rear parcel shelf or interior-trim component, the improvement comprising including the sandwich element according to claim 1.

3. One of a roof module, bonnet, tailgate module, door module, floor-panel module, load floor, rear parcel shelf or interior-trim component made according to the process of claim 2.

4. The sandwich element according to claim 1, wherein the core layer is constructed from at least one ply.

5. The sandwich element according to claim 1, wherein the two exterior outer layers are each constructed from at least one ply.

6. The sandwich element according to claim 1, wherein the two exterior outer layers are made of at least one material selected from the group consisting of glass-fiber mat, glass-fiber fleeces, glass-fiber random layers, glass-fiber cloth, cut or ground glass fibers, cut or ground mineral fibers, natural-fiber mats, natural-fiber knitted fabric, cut natural fibers and fibrous mats, fibrous fleeces and fibrous knitted fabric based on polymer fibers, carbon fibers or aramide fibers.

7. The sandwich element according to claim 1, wherein the core layer is made of at least one material selected from the group consisting of thermoformable and/or thermosetting polyurethane, thermoplastic foamed materials, paper honeycombs, metal honeycombs and plastic honeycombs.

8. The sandwich element according to claim 1, wherein the delaminating means is introduced during manufacture of the sandwich element.

9. The sandwich element according to claim 1, wherein the delaminating means is introduced subsequent to manufacture of the sandwich element.

* * * * *