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ACOUSTIC TILE LAMINATE

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Fig. 1.

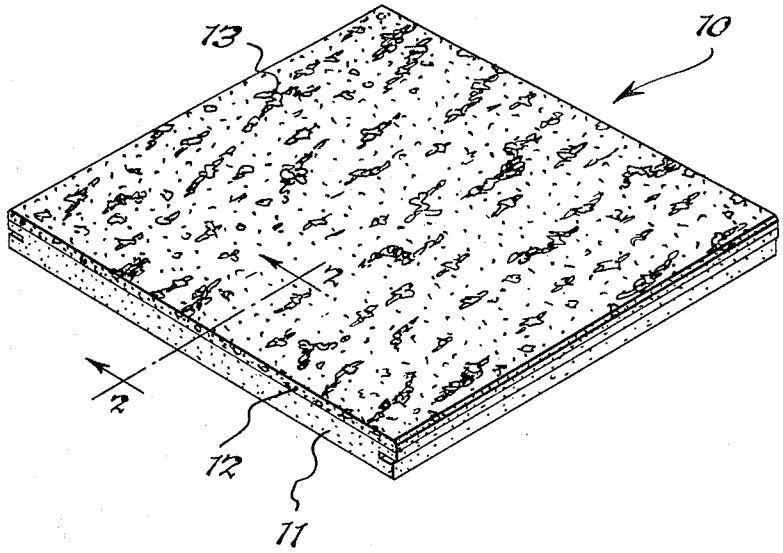
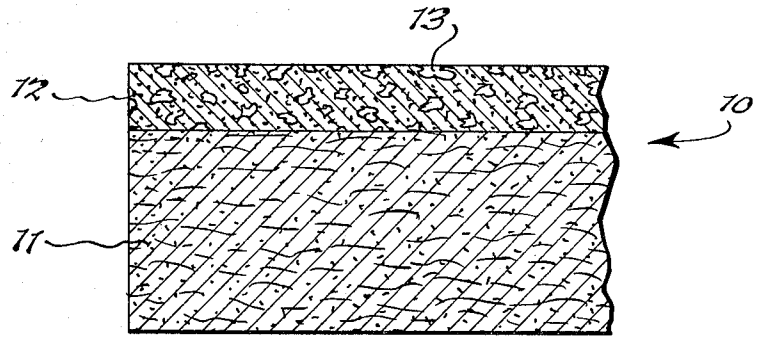


Fig. 2.



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ACOUSTIC TILE LAMINATE

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The present invention relates to an improved acoustic tile which is a laminate.

Various types of acoustic tiles are in common use. A first type is made of felted mineral wool in a pearl starch binder. This type has certain desirable physical properties, namely relatively low weight, relatively high strength, relatively high sag resistance, good dimensional stability and good sound absorbing qualities. However, this type does not provide a natural travertine stone-like facial appearance which is highly desirable from an aesthetic viewpoint. There is also in common use a second type of acoustic tile, namely, one having granulated mineral wool in a pearl starch binder, this type being cast, rather than felted as the first type, and therefore highly capable, because of its inherent structural nature, of giving a natural fissured travertine stone-like facial appearance as a result of being subjected to a conventional screeding process. However, this second type does not have as good physical properties as the above-mentioned first type. In the past, there was never any single acoustic tile capable of providing the above enumerated desirable properties of both of the foregoing types of tiles.

It is accordingly the object of the present invention to provide an improved acoustic tile, which is a laminate having the highly desirable structural properties of a felted mineral wool type of tile and also having the aesthetic desirable facial properties of a cast fissured mineral type of tile, without having the disadvantages of either, and without having shortcomings which would ordinarily be experienced as a result of merely laminating conventional tiles of the foregoing types. Other objects and attendant advantages of the present invention will readily be perceived hereafter.

Briefly, the present invention relates to an acoustic tile laminate having a felted mineral wool backing layer and a cast mineral wool facing layer joined thereto, with the resulting laminate possessing both the desired physical properties of the backing layer and the aesthetic visual properties of the facing layer and not being subject to the shortcomings which would ordinarily be experienced as a result of merely combining the above described types of acoustic tiles into a laminate. The present invention will be more fully understood when the following portions of the specification are read in conjunction with the accompanying drawing, wherein:

FIG. 1 is a perspective view of the improved acoustic tile laminate of the present invention; and

FIG. 2 is a fragmentary cross sectional view taken along line 2—2 of FIG. 1.

The improved acoustic tile laminate **10** of the present invention includes a backing layer **11** consisting of felted mineral wool in a starch binder and a surface layer **12** consisting of cast mineral wool in a starch binder, said layers being fused to each other by their starch contents, as will become more apparent hereafter. In addition, the surface layer **12** is only of sufficient thickness to provide the required penetration of the fissures **13** produced by a conventional screeding process.

In accordance with the present invention, the acoustic tile laminate is produced by laminating a modification of

the above mentioned cast mineral wool type of acoustic tile as a facing on the above mentioned felted mineral wool tile having greatly superior physical properties. In the foregoing respect it was found that the joining of a cast mineral wool having its normal 15% pearl starch content to a backing of felted mineral wool having its normal 8% pearl starch content resulted in the laminate being highly sensitive to changes in atmospheric humidity so that it warped with such changes, much in the nature that a bi-metallic element warps in response to changes in temperature. Obviously, this type of action was not commercially acceptable and it was subsequently found that such warping was due to the difference in starch content of the facing layer and the backing layer.

Varying the starch content of the backing layer so that it contained 15% pearl starch, the amount normally in the facing layer, in an attempt to obviate warping was found to be highly impractical and both commercially and economically undesirable inasmuch as a longer drying time of the wet felted product was required during manufacturing. Furthermore, it was found that the resulting product was more combustible and therefore had a lower fire rating. In addition, the sound absorbing qualities of the resulting product were inferior.

Inasmuch as it was found, as noted above, that it was the difference in starch percentages that caused the above noted warping, attempts to reduce the percentage of starch in the facing from its normal 15% to approximately 8%, as in the felted mineral wool backing, proved highly unsuccessful. In this respect, the facing with a reduced pearl starch content was too weak for commercial purposes and in addition its abrasion resistance was very poor because of its lack of body which in turn rendered the screeding process highly ineffective for producing the desired travertine fissured appearance.

In order to overcome the foregoing shortcomings resulting from attempts to equalize the starch contents of both the facing and backing layers it was found that if a waxy maize or milo type of starch was used in the facing layer together with a thickening agent, the starch binder would have improved binding qualities and thereby overcome the deficiency which would ordinarily be experienced as a result of the reduction of the starch content.

A commercial type of thickener which was found satisfactory is commercially known as Polyox* WSR–301 as will become apparent hereafter. In addition it was found that other thickeners commercially known as Jaguar* 550 and Methocel* H.G. could be used. These thickeners gave the facing material having a reduced starch content in the general range of the starch content of the backing layer a thicker body which was comparable to the body obtained with the 15% starch content so that the facial layer could be subjected to a screeding process which would provide the desired travertine stone-like appearance.

Essentially the improved acoustic tile laminate consists of a facing layer secured to a backing layer, with both layers including amounts of starch therein within approximately 3% of each other to thereby prevent warping of the laminate in response to variations in atmospheric humidity, with the facing layer having a thickening agent therein to compensate for the fact that its starch content has been greatly reduced from its normal 15% and therefore without said thickener lacking sufficient body to permit the mechanical working thereof to provide a travertine stone-like facial appearance.

A commercial method of manufacturing the above acoustic tile laminate is to place a felted mineral wool

composition containing, inter alia, between approximately 7% to 10% of pearl starch into trays lined with paper after the mat has been formed on a cylinder in the conventional manner. The compositions of the backing layer by weight in the dry state have been obtained within the following ranges:

	Percent
Clay, Baker*	6–10
Pearl starch	7.1–10.2
Wax emulsion X–251–A	0.6–0.7
Boric acid	0.6–0.7
Dowicide* A	0.04–0.05
Dowicide* G	0.04–0.05
Mineral wool	75–85
Moisture, maximum	1.5

The mineral wool used in the above composition is felted in the conventional manner and may consist of fiber lengths generally between ⅜ and ½ inch and possibly up to ¾ inch.

Thereafter the wet facing is laid into the trays containing the above described wet backing layer and the starch content thereof fuses with the starch content of the backing layer to provide a common binder joining both layers. The compositions of the face layer by weight in the dry condition have been obtained within the following ranges:

	Percent
Polyox*	.23–.46
Boric acid	.9–1.0
Tex-O-Film* #4838 starch	6.34–9.5
Clay, Allen*	11–14
Stucco	3–4
Wax emulsion X–251–A	1.4–1.8
Mineral wool	70–75
Moisture, maximum	1.5

Keobind* G starch has been substituted for the Tex-O-Film* #4838 in the same percent noted above. Also Jaguar* 550 has been substituted for the Polyox WSR–301 in the same percents noted above. Thus, within the formula noted above, three separate facing compositions have been successfully made. The first is noted above. The second included Keobind* G starch which was substituted for Tex-O-Film* #4838 starch in the above formula and in the same amount as the Tex-O-Film starch. The third composition utilized Jaguar* 550 thickener instead of the Polyox WSR-301 thickener and in the same amount as the latter, said thickener being utilized with the Tex-O-Film* #4838 starch noted above. In addition Methocel* H.G. has been used successfully in quantities which are 2½ times the amount of the Polyox* WSR–301 noted above. However, this was used only with the Tex-O-Film* #4838 starch. In the four above described compositions the remainer of the components were not changed except where the Methocel* H.G. was used and in this instance each of the other components of the composition were reduced by equal percents to compensate for the increased percentage of thickener.

In addition to the above range given in the formula, the Polyox* has been used in amounts as low as .186% and as high as .532% with the Tex-O-Film starch, and the Jaguar* has been used in amounts as low as .140% and as high as .532% with the same starch. The resulting laminates were satisfactory.

While commercially it has been found that the percentages of starch in both the facing layer and the backing layer may fall within the above ranges noted above, preferably the backing layer has between 8 and 8½% of starch content by weight and the facing layer has between 7 and 8% of starch content by weight. Preferably the starch in the backing should not be less than 7.1% and in the face not more than 8%. Actually the ranges given above as between 6.34 and 9.5% in the face and between 7.1 and 10.2% in the back result from the fact that the formulation of both the backing and facing composition is a continuous process, as will become more apparent hereafter, and there can be no pinpoint of an exact formulation which will be obtained.

In both the facing and backing layers the starch and mineral wool components provide the body of the layers. The wax emulsion acts as a sizing to prevent water penetration. The fungicides, namely, Dowicide* A and G and boric acid, function as fungicides while the materials are in both the liquid and solid states. Furthermore, the boric acid acts as a flame inhibitor in addition to being a fungicide. The clay in both the facing and in the backing provides body, fire resistance and high temperature dimensional stability. The stucco in the facing layer provides a certain amount of body and in addition provides whiteness.

After the face layer has been poured onto the backing layer the resulting slabs are dried to drive out the moisture and give the resulting laminate wherein the facing layer is secured to the backing layer as a result of the fusion of the starch binders as noted above.

In lieu of the above type of joining of the layers by fusion of their starch contents, dry sheets of each layer may be glued to each other by the use of suitable adhesives. In addition, if desired, a wet surface layer may be cast on a dried backing layer and the resulting laminate redried whereupon the binder in the wet surface layer will function as an adhesive.

A laminate has been made which consists of a backing layer which is approximately ¾ of an inch thick and a face layer which is approximately 3/16 of an inch thick. However, originally both the backing layer and the face are thicker than the final dimensions noted above, but both are planed to remove the surface areas. It is to be noted at this point that the facing layer is subjected to a screeding operation while it is wet to provide the desired travertine fissured appearance. It is also to be noted that the face is preferably only thick enough to provide the required depth of penetration of the screeding tools and no more. Successful laminates have been made in various overall thicknesses with the face layer being between ⅛ and ⅜ of an inch thick.

In order to make the backing layer noted above, a white water is formed having starch and Dowicide* A and G therein and all the other components listed above which are not subsequently filtered out. The mineral wool is added to the foregoing white water in a turbine type agitator and the two are thoroughly mixed. The total solids in solution are between 1 and 5%.

The mixture made in the turbine mixer is pumped to a storage tank, and from the storage tank the white water with the mineral wool are pumped to a "shot" separator where fresh binder is added. The resulting solution is injected into an Oliver board former. It is in the Oliver board former that the material is felted onto a rotating cylinder having vacuum on the inside thereof, and the mat so formed is laid into trays as described in detail above.

The facing is made up and is laid onto the wet backing. For the facing the binder consisting of all of the elements except the mineral wool is made up by dispersing the Polyox* WSR–301 thoroughly in cold water and adding the remainder of the ingredients in the order noted above where the composition of the facing was listed. Thereafter the batch is brought up to 195° F. and maintained at this temperature for a sufficient time to properly cook the starch, usually not less than five minutes. The binder and mineral wool are then fed simultaneously and continuously to a twin screw type mixer such as manufactured by the Sprout Waldron Company. In the solution the water consists of between 50 and 75% of the total. The twin screw mixer mixes both into a dough type of mix which is laid onto the above described backing in the trays.

Thereafter the laminate slabs so formed are baked at 350° F. maximum for no longer than six hours and thereafter the temperature is reduced to 300° F. plus or minus 10° F. for an additional four hours, and thereafter the

temperature is reduced to 280° F. plus or minus 10° F. until the slabs are dry, that is, contain less than 1% of their moisture content as noted above.

A series of tests have been made with various starch contents in both the facing layer and in the backing layer for the purpose of measuring the amount of warping in response to changing conditions of humidity. In the following table the results of such testing are set forth. These tests were made on 12" x 12" tile laminate samples having the indicated starch contents in both the facing and backing layers. In the facing layer Tex-O-Film* #4838 was used and a pearl starch was used in the backing layer, and the thickener was Polyox* WSR–301, all of the foregoing being combined according to the formulas set forth above. In the tests designated as "Oven," each tile was put in a room having 90% relative humidity and 90° F. temperature for 48 hours and thereafter dried at a 120° F. for 16 to 20 hours. The amount of warping was measured by placing a straight edge across the face of the tile 1" from and parallel to certain edges and measuring the distance between the straight edge and the tile at the middle of the tile. The figures for warping noted below in the table are maximum warpings which were observed along two of the four edges, any other warpings along the other edges being less. All of the foregoing results are within a range which is acceptable. The 20% relative humidity at 85° F. temperature test noted in the table indicate that those samples were dried under those conditions. The 10% relative humidity test noted in the table indicates that those samples were dried at 10% relative humidity and at 85° F. temperature.

TABLE A

Type of Test	Percent Starch		Warp in Thousandths of an Inch
	Facing Layer	Backing Layer	
Oven	6.34	7.85	.022–.030
Do	6.57	8.9	.012–.014
Do	6.65	8.25	.020–.030
Do	7.17	9.1	.004–.012
20% Relative Humidity, 85° F	7.0	9.6	.004–.006
Do	7.4	8.9	.003–.016
Do	7.4	9.7	.002–.008
Do	7.5	10.2	.002–.004
10% Relative Humidity	7.7	7.6	.006–.008
Do	7.85	7.85	.004–.006
Do	8.0	7.7	.004–.010
Oven	8.25	8.5	.005–.010
Do	8.4	7.9	.012–.016
Do	8.5	8.4	.010–.010
Do	8.5	8.65	.024–.024
Do	8.75	8.4	.020–.028
20% Relative Humidity	9.3	8.0	.025–.026
Oven	9.5	9.1	.010–.034
10% Relative Humidity	7.5	7.6	.016–.018
Do	8.1	7.1	.002–.026
Oven	8.25	8.5	.006–.010
Do	8.5	8.4	.010–.010
Do	7.8	9.5	.014–.014
Do	8.0	10.15	.010–.015

In the above tests the starch contents were determined by analyzing the actual samples which were tested for warp.

Additional tests were made using Keobind* starch with Polyox* WSR–301 in the same range noted above in the formula and the following results were obtained. The analysis of the starch content was made of the tiles which were actually tested for warping.

TABLE B

Type of Test	Percent Starch		Warp in Thousandths of an Inch
	Facing Layer	Backing Layer	
Oven	8.1	9.55	0–.012
Do	8.3	9.6	.010–.020

The following tests were made of a laminate having Tex-O-Film* #4838 starch with Jaguar* 550 thickener within the range of percentages shown in the formula. This test differed from the above tests in that while tiles, such as noted above were tested for warping, it was immediately adjacent pieces from the same batch which were tested for starch content. In both items noted below the range of starch contents was for eight pieces of tile laminate.

TABLE C

Type of Test	Percent Starch		Warp in Thousandths of an Inch
	Facing Layer	Backing Layer	
Oven	7.85–8.05	10.25–10.3	0–.020
Do	6.7 –7.1	10.2 –10.3	0–.024

The composition of each of the components of both the facing layer and the backing layer are as follows:

The Polyox* WSR–301 is a product of the Union Carbide Company and consists of ethylene oxide polymer including approximately 2% ash content by weight and approximately 4% moisture content by weight. In addition this material has a softening point of between 65–75° C. and a brittle temperature of minus 50° C. and a molecular weight of 4×10^6.

The boric acid is of 99.5% minimum purity and has a maximum of .01% chloride, .10% sulfate and .0005% iron.

The Tex-O-Film* #4838 is a product of the Corn Products Sales Company and is a milo starch having 12½% maximum moisture, .5% maximum ash content, and a pH of between 6.0 and 7.0.

The Keobind* G is a highly refined starch derived from "waxy" type corn and made by the Hubinger Company. It is milled, separated and refined by the wet process. Its physical form is white pearl or powder and it consists of moisture 9.5–12.5%; solubles .4% maximum; protein .45% maximum; ash .5% maximum; fat, ether extractable .05% maximum; and has a pH of between 5.0 and 6.0. The Keobind* G is resistant to the thinning action of acidic materials, and is also resistant to breakdown and loss of body resulting from agitation and lengthy cooking. It also has relatively high adhesive properties.

The Allen Clay* is a product of United Clay Mines, Inc. and a typical analysis shows the existence consists of the following ingredients by percent: silicon dioxide 45.02, aluminum oxide 38.32, iron oxide .46, calcium oxide .06, magnesium .14, alkalies .36, titanium dioxide 1.66. In addition, the pH is 4.8 and it has a size wherein 99% passes through a 325 mesh screen. The only basic difference between Allen Clay and Baker Clay is their color.

The Gypsum Stucco has a consistency of 49–55 ml. according to ASTM Designation C472–61, a minimum set time of 42 minutes, and a size wherein .4% is the maximum which should be retained on an United States No. 30 Sieve and 87% is the minimum which should pass through a United States No. 100 Sieve.

The Wax Emulsion X–251–A is a product of the American Cyanamid Company, the X–251–A being the grade designation. It consists of an emulsion of wax in water wherein the solids are 47 plus or minus 1% and it has a stability of six months at 75° F.

The mineral wool which forms a part of the face of the tile laminate is a granulation of zero percent plus ¾ inch screen and 5–25% plus ½ inch screen and has a diameter of 3 to 30 microns.

The mineral wool which is used in the backing is of a size wherein 30% minimum must be above a ¾ inch screen and 20% maximum must be minus a ¼ inch

screen and it has a diameter of approximately 3 to 30 microns.

In addition, both of the mineral wools have a composition which is 38–42% of silicon dioxide, 36–40% of calcium oxide, 6–10% of aluminum oxide, 4–8% of magnesium oxide and less than 1% of the trace elements iron, titanium, manganese and sulfur.

The pearl starch is a white corn starch and has between 10½ and 13½% moisture and includes .10% maximum ash, .30% maximum protein, .10% maximum fiber, .10% maximum water soluble substances, .003% maximum SO_3, .10% maximum fat, 86% minimum starch by difference, and a pH of between 5.0 and 7.0.

The Dowicide* A is a product of the Dow Chemical Company and is of a flake grade having a solubility in water of .122 grams/100 grams and includes 97% minimum active ingredients comprising sodium ortho phenyl phenate and 3% maximum inert ingredients. The pH of a saturated water solution at 25° C. is between 12.0 and 13.5.

The Dowicide* G is a product of the Dow Chemical Company and is of the flake grade and includes 90% minimum of sodium salt of pentachlorophenol and 10% maximum of inerts. This material is of flake grade and has a minimum solubility of 33 grams in 100 grams of water at 25° C.

The Jaguar* 550 is a blend of guar gum and a small amount of polyacrilimide and the guar gum is a natural product of manose and glatose type sugars. The Jaguar* 550 is a product of Stein, Hall & Co., Inc.

The Methocel* H.G. is a product of the Dow Chemical Company and is essentially a hydroxypropyl methylcellulose product.

In the preceding specification, all names designated by an asterisk are trademarks.

By the foregoing, a laminate acoustic tile is provided having the desirable physical properties of felted mineral wool tile and in addition having the desired natural travertine fissured appearance of cast mineral wool without possessing the shortcomings resulting from the combination of both types in their previous known forms.

What is claimed is:

1. An acoustic tile laminate comprising a backing layer consisting essentially of felted mineral wool and a starch binder; a facing layer consisting essentially of a cast mineral wool, a starch binder and a thickening agent for said starch binder; said starch binder of said facing layer being between about 6.3 and 9.5 percent of the facing layer by weight and said starch binder in said backing layer being between about 7 and 10 percent of said backing layer by weight to thereby minimize the tendency for warping of said laminate as a result of variations in atmospheric humidity; said thickening agent in said facing layer being present in an amount sufficient to thicken the body of the facing layer sufficiently to permit said facing layer to assume a travertine stone-like facial appearance when subjected to mechanical working.

2. An acoustic tile laminate as set forth in claim 1 wherein said starch in said backing layer is a pearl starch and wherein said starch in said facing layer is selected from the class consisting of waxy maize and milo starches.

3. An acoustic tile laminate comprising a backing layer consisting essentially of felted mineral wool in a starch binder; and a facing layer consisting essentially of cast mineral wool, a starch binder, and a thickening agent for said starch binder; said facing layer being bonded to said backing layer by the fusion of said first and second starch binders with each other; said starch binders being within about 3% of the same percentage by weight of the total weight of the layers with which they are associated to thereby minimize the tendency for warping of said laminate as a result of variations of atmospheric humidity; said thickening agent in said facing layer being present in an amout sufficient to thicken the body of the facing layer sufficiently to permit said facing layer to assume a travertine stone-like facial appearance when subjected to a mechanical screeding process.

4. An acoustic tile laminate as set forth in claim 3 wherein said backing layer is of greater thickness than said surface layer.

5. An acoustic tile laminate as set forth in claim 3 wherein said percentage of starch binder in said facing layer is between about 6.3 and 9.5% and in said backing layer is between about 7 and 10%.

6. An acoustic tile laminate as set forth in claim 5 wherein said starch in said backing layer is a pearl starch and wherein said starch in said facing layer is selected from the group consisting of waxy maize and milo starches.

7. An acoustic tile laminate as set forth in claim 6 wherein said surface layer is only of sufficient thickness to provide a travertine stone-like facing as a result of a screeding process.

8. An acoustic tile laminate comprising a backing layer consisting essentially of felted mineral wool in a starch binder; and a facing layer bonded to said backing layer and consisting essentially of cast mineral wool, a starch binder and a thickening agent for said starch binder; said starch binders being within about 3% of the same percentage by weight of the total weight of the layers with which they are associated to thereby minimize the tendency for warping of said laminate as a result of variations in atmospheric humidity; said thickening agent in said facing layer being present in an amount sufficient to thicken the body of said facing layer sufficiently to permit said facing layer to assume a travertine stone-like facial appearance when subjected to a mechanical screeding process.

9. An acoustic tile laminate comprising a backing layer consisting essentially of felted mineral wool in a starch binder; and a facing layer consisting essentially of cast mineral wool, a starch binder and a thickening agent for said starch binder; said starch binders of both said facing layer and said backing layer being present in relative amounts which will minimize warping of said tile laminate in response to variations in atmospheric humidity.

10. An acoustic tile laminate comprising a backing layer consisting essentially of felted mineral wool in a starch binder and a facing layer bonded to said backing layer and consisting essentially of cast mineral wool, a starch binder and a thickening agent of said starch binder present in an amount sufficient to thicken the body of said facing layer sufficiently to permit said facing layer to assume a travertine stone-like-appearance when subjected to mechanical working.

11. An acoustic tile laminate comprising a backing layer consisting essentially of felted mineral wool in a first starch binder; a facing layer bonded to said backing layer and consisting essentially of cast mineral wool, a second starch binder, and a thickening agent for said second starch binder; said first starch binder being present in an amount not less than about 7.1% of the total weight of said facing layer and said second starch binder being present in an amount not more than about 10.15% of the total weight of said backing layer.

12. An acoustic tile laminate comprising a backing layer consisting essentially of felted mineral wool in a starch binder; a facing layer bonded to said backing layer and consisting essentially of cast mineral wool, a starch binder, and a thickening agent for said starch binder; each of said starch binders being present in about the same percentage by weight of the total weight of each of the layers with which it is associated to thereby minimize the tendency for warping of said laminate as a result of variations in atmospheric humidity; said thickening agent in said facing layer being present in an amount sufficient to thicken the body of said facing layer sufficiently to permit said facing layer to assume a traver-

tine stone-like facial appearance when subjected to a mechanical screeding process.

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