

[54] **CONCRETE STRUCTURAL MEMBER WITH HIGH INTERNAL DAMPING**

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[51] Int. Cl. **E04c 3/34**

[58] Field of Search 52/573, 396, 403, 410, 52/722, 723, 309, 730, 612, 167; 188/1 B; 181/33 R

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[57] **ABSTRACT**

A concrete structural member comprises at least two elongated concrete elements completely spaced from one another by a continuous intervening layer of viscoelastic material in full surface engagement with each element. The viscoelastic material has a thickness which is a small fraction of the thickness of each element, a modulus of elasticity of 10^6 – 10^8 N/m², and a loss factor exceeding 0.5.

10 Claims, 14 Drawing Figures

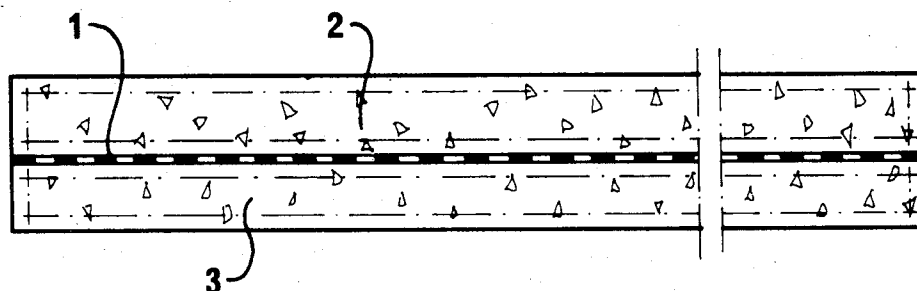


FIG. 1

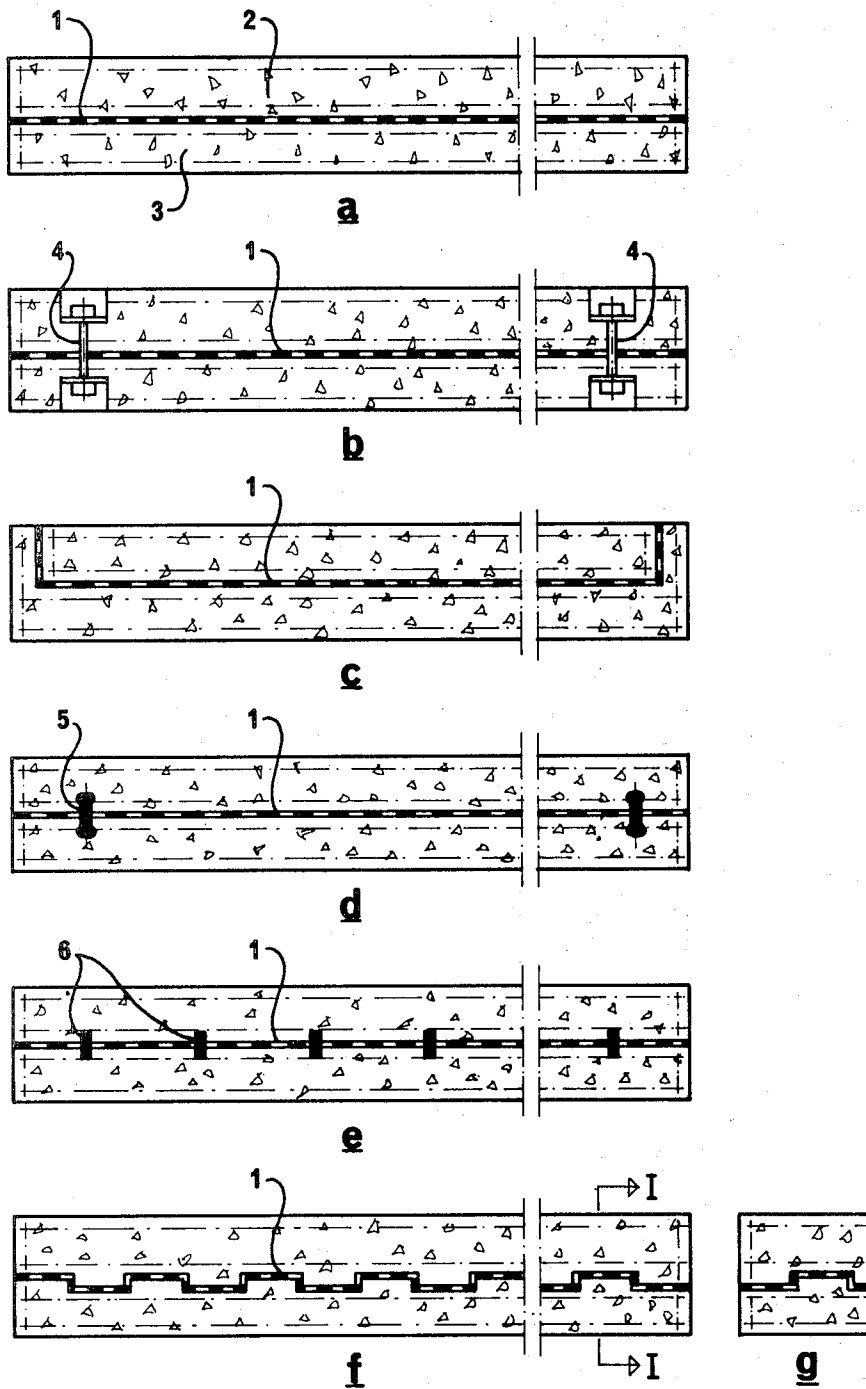


FIG. 2

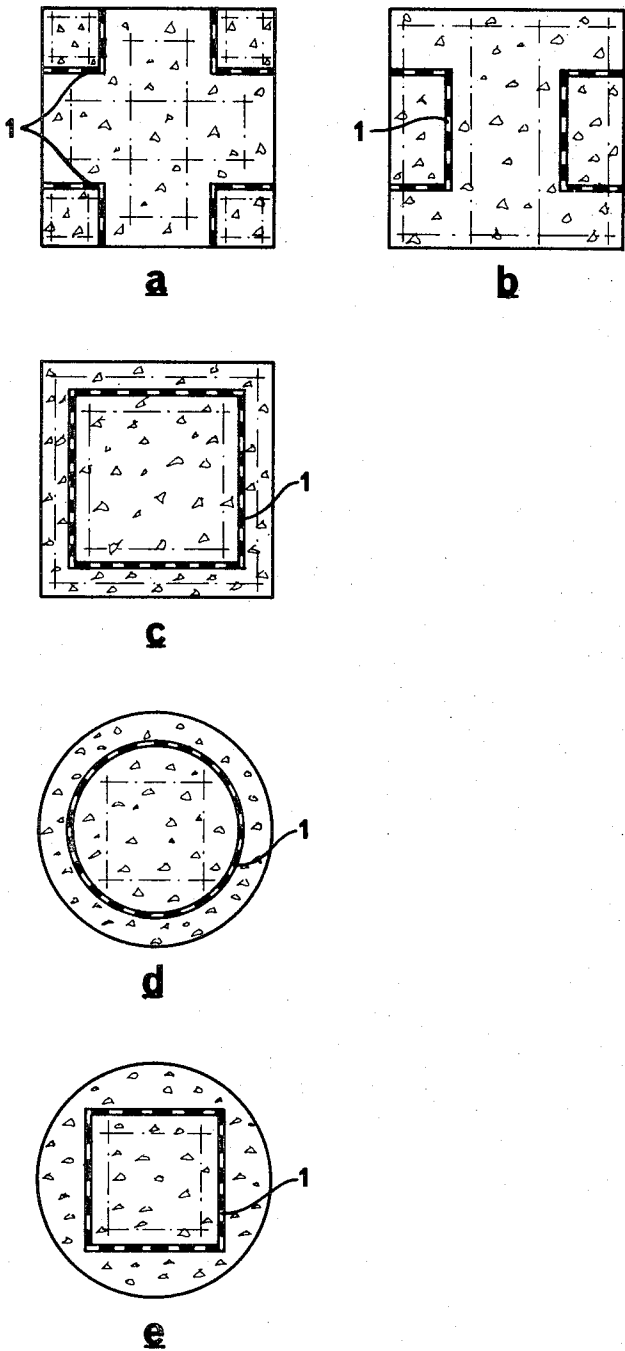


FIG.3

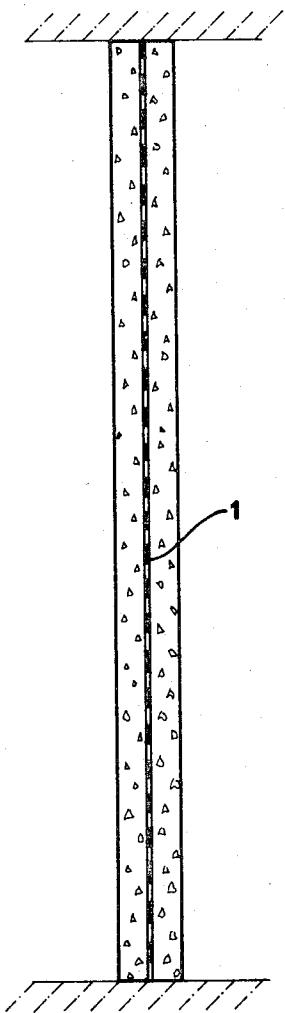
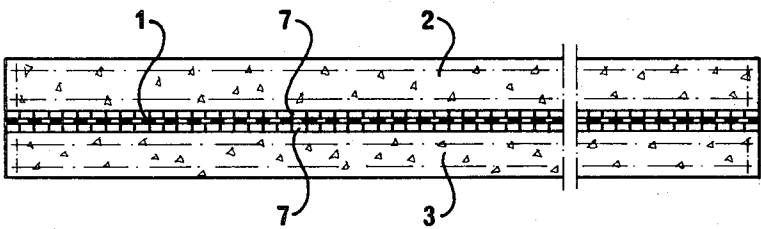


FIG.4



CONCRETE STRUCTURAL MEMBER WITH HIGH INTERNAL DAMPING

CROSS-REFERENCE TO RELATED APPLICATION

The present application comprises a continuation in part of U.S. application Ser. No. 146,776 filed May 25, 1971 now abandoned.

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to a method for obtaining high internal damping in a concrete or light concrete construction.

A problem more and more paid attention to in connection with house construction is the unprevented transmission of structure-born noise through homogenous concrete beams and concrete walls (inclusive of lift or elevator shafts, staircases etc.). Surge from water being flushed, doors being banged, people walking in stairs, elevator transports, disturbing activities from workshops in the same house, printing presses etc., vibrations from road traffic, underground railway etc., cause embarrassing noise, which can be limited only at great costs. The flanking transmission of air noise via for instance elements of light concrete is also a great problem.

A homogenous concrete slab reinforces vibrations imparted thereto about 100 times by resonance oscillations (bending vibrations) and the propagation damping is low (for bending waves < 0.1 dB per m at 100 Hz). A high-grade reduction of the reinforcing factor by the increase of the interior losses in the slab and a heavy increase of the impedance and the propagation damping connected thereto are the fundamental prerequisite to manage the problems with structure-born noise.

One of the methods among those so far used for increasing the internal damping in concrete elements is testing to a limited extent concrete elements with cavities filled with sand, which has increased the internal damping by factors of 2-5 depending on the frequency range, grain size, the distribution of the cavities etc. This method is rather expensive and uncertain. The sand must be homogenous and the cavities must be of irregularly varying size to avoid compaction and to obtain an increase of the internal damping in a sufficiently wide frequency range. Casting of rubber or plastic material into the concrete has also been tried and a damping by factors of 5-10 has been obtained.

By using in a suitable manner the very high energy absorption (damping ability) of certain viscoelastic materials when being exposed to shearing it is possible to construct elements with an internal damping increased by a factor of 20.

The principle for this is known from aviation, missile and satellite technique, where it is used for damping thin plates. A layer of viscoelastic material is then disposed between two plates. The laminated product thus accomplished is normally and in the following called sandwich plate. Such damping applications, and viscoelastic materials used for that purpose, are described in "Shock and Vibration Handbook," Vol. 3, by C. M. Harris and C. E. Crede (McGraw-Hill Book Co., Inc., 1961). One viscoelastic material adapted for this purpose, as shown in table 36.4 of said Handbook, is polyvinyl chloride acetate, which gives satisfactory damping in the frequency range above 100 Hz and within the

temperature range of 21° - 65° C. It is typical, for thin layers useful to absorb energy at shearing, that the layer of viscoelastic material has a modulus of elasticity $E = 10^6$ - 10^8 N/m² (Newton per square meter) and a loss factor exceeding 0.5.

The thickness of the viscoelastic layer used in sandwich plates is typically of a magnitude 0.1-1 mm, i.e., it is of substantially the same order of magnitude as the plates between which it is placed. Starting from this there might be reason to expect that correspondingly thick viscoelastic layers must be used for damping relatively thick concrete constructions. In tests for damping concrete constructions, however, it has surprisingly been found that viscoelastic materials exist for which a layer of the same thickness as has been used in sandwich plates gives perfectly satisfactory damping (factor 20-30) of concrete elements, for instance beams, slabs, walls and columns.

Thus, the invention relates to a method for obtaining high internal damping in a concrete or light concrete construction characterized by the features defined in the following claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in the following with reference to the drawings, which show different constructions produced by the method of the invention.

FIG. 1a-f showing sections through different beams or slabs and

FIG. 1g a section along the line I-I in FIG. 1f, FIG. 2a-e showing sections through different columns,

FIG. 3 a vertical section through a wall and

FIG. 4 a section through another construction.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 shows the principle for the arrangement of the viscoelastic layer 1 between two constructional parts 2 and 3.

In the constructions shown in FIG. 1 the viscoelastic material layer 1, for transmitting bending oscillations in the construction to shearing in the viscoelastic layer, is positioned in the neutral plane of the respective construction or close to the same. In the substantially horizontal construction shown in FIG. 1 the viscoelastic layer can be applied in the form of a foil or film or the like or by spraying on to the lower constructional part 3, after which the upper constructional part 2 is positioned. Applying can take place on constructional parts already cast or when being cast.

For avoiding displacement of constructional parts relative to each other along the parting line, suitable means can be included for limiting such motion. In FIG. 1b such means are shown in the form of bolts 4 passing through the two constructional parts. In FIG. 1c the parts are shaped per se so that a relative motion along the parting line is restricted. In FIG. 1d and 1e motion restricting elements 5 and 6, respectively have been cast into the lower constructional part during casting of the constructional parts, after which the upper constructional part has been cast into place with the viscoelastic layer 1 and the elements 5 and 6, respectively, being recessed into the upper and lower parts, respectively. In FIG. 1f and 1g another construction is shown, where the cooperating shape of the parts limits said motion.

In FIGS. 2a-e various examples are shown illustrating how the viscoelastic layer 1 can be included in columns, and in FIG. 3 such a layer 1 is shown included in a wall construction. In vertical constructions, such as those according to FIG. 2 and FIG. 3, the layer 1 can be applied by spraying or by hanging a foil or the like of the viscoelastic material in the boundary surfaces between the parts of the respective construction at the time of their manufacture.

In the construction shown in FIG. 4 a stiff layer 7 is located between the finished constructional parts 2 and 3, respectively, and the viscoelastic layer 1, which layer 7 has communicating pores for pressing out air at the time the constructional parts are joined together.

Suitable viscoelastic materials for use with the present invention are certain plastic materials, preferably thermoplastic materials.

As an alternative to the use of a foil of the viscoelastic material also the aforesaid so-called sandwich plates can be used, which include such a layer, as mentioned above.

Having thus described our invention, we claim:

1. A concrete structural member having high internal damping, said member including at least two concrete elements completely spaced from one another by at least one continuous, intervening layer in full surface engagement with each of said elements and comprising a viscoelastic material operative to absorb essential energy at shearing, said viscoelastic material having a thickness which is a small fraction of the thickness of each of said elements, and said viscoelastic material having a modulus of elasticity of $10^6 - 10^8$ N/m² and a loss factor exceeding 0.5.

2. The structural member of claim 1 wherein said viscoelastic material has a thickness of substantially 0.1-1

mm.

3. The structural member of claim 1 wherein said structural member is of elongated configuration and is adapted to be exposed to bending forces, said viscoelastic material being disposed closely adjacent the neutral plane of said member.

4. The structural member of claim 1 wherein said concrete elements are each of elongated configuration, said layer of viscoelastic material extending throughout substantially the entire length of said member.

5. The structural member of claim 4 including means for restricting movement of said elongated elements relative to one another in the direction of extension of said intervening layer.

6. The structural member of claim 5 wherein said means for restricting relative movement engages each of said concrete elements and extends in a direction transverse to the direction of extension of said layer.

7. The structural member of claim 5 wherein said means for restricting relative movement comprises complementary facing internal portions of said concrete elements extending in directions transverse to the direction of extension of said layer.

8. The structural member of claim 7 wherein said layer consists of a foil of viscoelastic material.

9. The structural member of claim 1 wherein said layer is of laminated, sandwich plate construction and comprises a lamination of viscoelastic material disposed between a pair of thin plates.

10. The structural member of claim 1 wherein said layer comprises a layer of viscoelastic material in engagement with at least one, comparatively stiff layer having a plurality of pores therein.

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