

A Settable Mixture and a Method of Manufacturing a Sound Insulating Floor Construction

5 The present invention relates to a settable mixture comprising magnesium oxide and magnesium chloride. The invention further relates to a method of manufacturing a sound insulating floor construction.

10 Mixtures of magnesium oxide and magnesium chloride, sometimes referred to as Sorel cement, are known in the art for application as binders for industrial floorings, for which purpose they are favoured on account of high elasticity and bending tensile strength properties. It is also known in the art to manufacture lightweight building
15 slabs comprising Sorel cement in combination with wood chippings.

International patent publication no. WO89/02422 discloses a settable magnesium cement composition comprising
20 magnesium oxide, magnesium chloride and coarse fibrous long-stranded sawdust. In the composition suggested the content of magnesium chloride constitutes approximately one third of the content of magnesium oxide as measured by weight. Suggested applications comprise use as a floor
25 levelling compound or manufacture of moulded products such as tiles and the like. Particular advantages claimed with this composition comprise reduction of sweating, reduction of dust, better control over product quality, sound attenuation among others.

30 German published patent application DE 41 08 562 suggests for a floor levelling compound a mixture of coarse wood chips with granulated foamed polystyrene together with ceramic aggregates and a hydraulic binder such as cement

or plaster of Paris. The publication contains in respect of the ceramic aggregate also suggestions for expanded clay aggregate or pumice and others.

5 The inventor has found that Sorel cement is highly prone to expand during setting. Relative expansions in the order of 1% are very likely. Given this rate of expansion a floor slab may, depending on dimensions and boundary constraints, crack and break up. The expansion takes place
10 slowly but keeps growing over an extended period of time. This makes the expansion difficult to monitor accurately during the early stages and means that a risk of selfdestruction is there for a long period.

15 The expansion propensity practically limits the use of Sorel cement to applications as a binder, to products cast in moulds or to floor levelling compounds laid in comparatively thin layers and adhered to a floor base, which serves to keep the Sorel cement layer in position.

20 The inventor has found that the admixing of wood fibres in any substantial amount tends to make the mixture sticky and viscous and hence difficult to mix properly and difficult to apply. Improper mixing is detrimental to the
25 structural integrity of the hardened product and likely to aggravate expansion problems.

The invention provides a mixture as recited in claim 1. This mixture combines the advantageous effects of Sorel
30 cement in high elasticity and bending tensile strength as well as sound attenuation in a material where the expansion propensity is a factor of ten lower than is the case in other Sorel cements. Expansion rates in the order of one per thousand are easily achieved, meaning that even

large slabs may be cast without any problems. The mixture is easy in mixing and in application. The strength of the mixture when set is comparable to that of ordinary cements.

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This performance of the inventive mixture is believed to be attributable to a number of factors. The filler material serves to dilute the expansion propensity by replacing corresponding volumes of magnesium oxide and magnesium chloride. The resiliently compressible fibres are believed to restrain expansion while also being capable of absorbing expansion internally through compression.

15 Although a range of proportions between the ingredients may be used, it is believed that roughly equal portions by weight of $MgCl_2$ and MgO will further the formation of strong and stable crystal structures in the product when set.

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According to a preferred embodiment the resiliently compressible fibres comprise ligneous fibres such as wood chips or sawdust. These fibres are preferably finely grained in order that the liquid mixture will stay fluent until it sets.

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According to a preferred embodiment the filler material comprises an expanded material. The expanded material reduces the density of the compound and permits internal absorption of expansion, the spheres of the expanded material being capable of collapsing internally so as to relieve any pressure in the immediate surroundings. The spheres of the expanded material do not corrupt the fluency of the mixture.

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According to a preferred embodiment a part of the filler material comprises comminuted aggregate such as fine gravel or stone dust. These materials contribute to the excellent strength of the mixture when set.

The invention further provides a method of manufacturing a sound insulating floor construction on top of a floor base and within confinement walls as recited in claim 10.

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This method provides a floor comprising a floating slab made of the inventive mixture. The floating arrangement of this slab by the soft resilient support under the bottom as well as along all sides decouples any body transmission of sound or vibration waves and hence achieves excellent sound insulation capabilities. The insulation properties are further enhanced by the inherent sound deadening features of the inventive mixture. The floor slab may be cast in situ even in very large formats.

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Although this floor construction is generally applicable it is particularly favoured in critical fields of application such as accommodations on ships where spaces are narrow and where the requirements to weight, sound insulation, vibration insulation and fire resistance are extreme.

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Further features, advantages and objects of the invention will appear more clearly from the appended detailed description of particular modes of execution, referring also to the appended drawings, whereon

Fig. 1 is a diagram illustrating expansion in specimens made of two Sorel cement compounds, specimen A

comprising a compound according to the invention,
specimen B comprising a Sorel cement compound
according to the prior art, and

5 Fig. 2 is a vertical section through part of a sound
insulating floor construction according to the
invention.

Example A:

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The following ingredients and quantities were apportioned:

70 kg water,

50 kg magnesium chloride,

15 50 kg magnesium oxide, and

157 kg ballast.

The ballast comprises a premix including, as measured by
volume,

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one part of expanded clay aggregate,

one part of stone dust, and

two parts of fine wood chips.

25 157 kg of this premix fills a volume of 193 litres.

Magnesium chloride is mixed with water and stirred until a
homogenous mixture is obtained. Thereafter magnesium oxide
and ballast is admixed.

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In a variant of this procedure water is not apportioned in
advance but rather added to the magnesium chloride, which
is stirred while the density of the slurry is monitored. A
proper mixture is obtained when the magnesium chloride is

well slurred and the density is in the range between 1.16 and 1.20 g/cm³.

5 The specimens were cast and set. The density of these specimens was approximately 1.3 g/cm³.

Compression tests have been carried out on samples cast in the mixture of example A. Test specimens proved capable of supporting a loading of 20 MPa before fracturing.

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Example B:

Ingredients as in example A except for the ballast which was here replaced with 250 kg fine gravel which mass fills
15 a volume of 193 litres. Mixing procedure as in example A.

Example C:

20 The following ingredients and quantities were apportioned:

70 kg water
50 kg magnesium chloride
50 kg magnesium oxide, and
112 kg ballast

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The ballast comprises a premix including as measured by volume:

6 parts of fine wood chips,
30 3 parts of expanded clay aggregate,
3 parts of expanded perlite, and
2 parts of expanded fly ash

Test specimen were cast and set. The density was 0.9 g/cm^3 . Compression tests revealed that the strength is somewhat lower than that of the example A specimen.

5 Test specimens measuring $100 \times 100 \times 400 \text{ mm}$ were cast with the mixture of example A and with the mixture of example B. The test specimens were allowed to set in a controlled climate at a temperature of 23°C and 43% relative humidity. Expansion during setting was recorded at various
10 intervals through approximately 9 days.

Results of these measurements are given in the graph in fig. 1. This graph reveals for both test specimens a relatively rapid expansion during the first 48 hours. From
15 this instant the curves separate, specimen A exhibiting after 216 hours an expansion of approximately $0.73/1000$ and with a tendency to level off from at this point onwards, whereas specimen B exhibited an expansion of about $1.16/1000$ at the same instant and still growing at
20 an undiminished rate.

It is noted that the particular expansion may depend on the particular dimensions and shape. Anyway, the curve confirms that the expansion of the inventive mixture is
25 far lower than that of other mixtures and within acceptable levels.

Figure 2 illustrates a vertical section through part of a
30 ship accommodation wherein a sound insulating floor construction has been installed. The ship accommodation is basically installed on top of a horizontal floor base 1 and within vertical bulk head walls 2, both comprising solid steel plates which are part of the ship structure.

On top of the floor base a layer of soft resilient mats 3, such as mineral wool fibres or rockwool is applied. The thickness of these mats may be in the range from 10 to 200
5 mm, e.g. 50 mm.

Above this layer of mats and along the bulk heads a spacer list 4 comprising also a soft resilient material such as mineral wool fibres or rockwool is placed. The vertical
10 dimension of this list may in one example be 25 mm, the horizontal extension may be 10 mm. Using the layer of mats and the lists as a form, a mixture prepared according to example A is poured and screeded to form a layer of a depth of 25 mm and allowed to set. When cured the mixture
15 forms a solid slab, supported and constrained with resilient mineral fibres and with no body contact with the ship structure. The cured slab is covered by a carpet 6 which provides an attractive top surface.

20 This floor construction exhibits excellent sound attenuation performance. The slab supports all normal use, e.g. the placing and moving of furniture and even the installation of light partition walls directly on top of the slab.

25 The floor construction has been successfully installed in a ship accommodation measuring 20 by 50 m. The floor slab was cast in one piece, covering the entire area and with no form of expansion joints. No cracking has been
30 observed.

The structure may, depending on the thickness of the rockwool mats, be installed to a building height from 35 mm and the weight added by this floor construction may be

as low as 37 kg/m² with a 25 mm slab composed according to the example A on top of 30 mm rockwool mats or as low as 27 kg/m² with a 25 mm slab composed according to the example C on top of 30 mm of rockwool mats.

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Although, various components, designs and methods have been explained in particular examples above this is not to exclude that such components, structures and methods could be applied in other set-ups, might be configured differently or might be separately patentable. Although particular examples have been mentioned, the detailed explanation has the sole purpose of facilitating understanding the invention and is not intended to limit the scope thereof which is defined exclusively by the appended patent claims.

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P a t e n t C l a i m s

1. A settable mixture comprising
 - magnesium oxide,
 - 5 - magnesium chloride,
 - water,
 - resiliently compressible fibres, and
 - a filler material.
- 10 2. The mixture according to claim 1, wherein the resiliently compressible fibres comprise ligneous fibres, such as wood chips or sawdust.
- 15 3. The mixture according to claim 1 or 2, wherein the filler material comprises a grained, substantially non-water absorbing material.
- 20 4. The mixture according to claim 3, wherein a part of the filler material comprises an expanded material, such as expanded clay aggregate, expanded glass, expanded polymere or pumice.
- 25 5. The mixture according to claim 3 or 4, wherein a part of the filler material comprises comminuted aggregate, such as fine gravel or stone dust.
- 30 6. The mixture according to any of the preceding claims, said mixture comprising
 - between 12 and 18% by weight of MgO,
 - between 12 and 18% by weight of MgCl₂,
 - between 36 and 50% by weight of H₂O, and
 - balance up to 100% of fibres and filler.

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7. The mixture according to claim 6, wherein the balance comprises between 40 and 60% by volume of ligneous fibres.
- 5 8. The mixture according to claim 6 or 7, wherein the balance comprises between 20 and 30% by volume of expanded material.
9. The mixture according to claim 6, 7 or 8, wherein
10 the balance comprises between 20 and 30% by volume of comminuted aggregate, such as fine gravel or stone dust.
10. A method of manufacturing a sound insulating floor construction on top of a floor base and within
15 confinement walls, said method comprising:
- applying on top of the floor base a layer of soft, resilient mats,
 - arranging along the confinement walls and at least partially above the top side of the layer of mats a spacer
20 list comprising a soft, resilient material,
 - pouring on top of the mats a mixture comprising magnesium oxide, magnesium chloride, water, resiliently compressible fibres and a filler material,
 - levelling the top surface of the mixture, and
25 - allowing it to set to form a solid slab.

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