



International Committee of the Decorative Laminates Industry

Technical Leaflet

Bonding and Processing of HPL on mineral substrates

November, 2013

Preface

Decorative laminates according to EN 438 are an excellent material for indoor and outdoor surfaces. They can be used either applied to suitable substrates or as self-supporting compact sheets. Decorative laminates meet the stringent requirements for hygiene, fire resistance humidity resistance and mechanical properties. Decorative laminates are available in a variety of colours, patterns and surface textures, providing extensive options for architects and designers. Decorative laminate surfaces are hard and resistant to wear, impact and scratching, making them long lasting, easy to clean and largely resistant to vandalism.

In addition to their physical properties, decorative laminates offer other benefits including quick and easy installation of compact laminate panels, and in renovation applications using dry construction methods, elimination of the need to remove existing wall coverings such as wallpaper, textile coverings, or ceramic tiles. The technical leaflet "*Bonding and Processing of HPL on mineral substrates*" contains information about manufacturing these composite elements as well as an overview and valuable recommendations on bonding processes, attachment methods and design considerations. This technical leaflet is an update and an expansion of the previous version on the same topic issued in May 1989.

This document does not claim to provide a complete review or listing of contents of any of the standards referred to in the text.

All information is based on the current state of technical knowledge, but it does not constitute any form of liability. It is the personal responsibility of the user of the products described in this information leaflet to comply with the appropriate laws and regulations.

For more than 50 years the ICDLI has been the international representative of the interests of European laminate manufacturers. Further information about the ICDLI and the data sheets published up to now can be found at www.icdli.com

This application was compiled by the International Committee of the Decorative Laminates Industry.

It considers the conditions of application technology in the European countries. If you have further questions, please contact us:

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1. General information

Composite elements made using decorative high pressure laminate (HPL) and mineral substrates have a wide field of application and are often mandatory where increased fire resistance is required due to revised fire regulations (e.g., high-rise buildings, ship building or public transport).

The recommendations for processing described in this technical leaflet are intended to support the manufacturers of composite elements with mineral substrates. A description and type classification for decorative laminates can be found in the technical leaflet "*General recommendations for working with decorative laminates*".

Resins used to make decorative laminates are thermosets and once cured do not melt or drip when burned. They are generally free from substances which lead to corrosion in case of fire and feature a relatively low development of smoke and combustion gas.

2. Material requirements and approval regulations

These processing guidelines apply to decorative laminates type S (standard quality) or type F (fire-retardant quality) according to EN 438 or ISO 4586-1.

The laminate type to be selected depends on the field of application and the fire regulation requirements.

Nearly all fire regulations require materials which are subject to special testing and must be approved in the configuration in which they will be installed in the field. Approval is therefore granted not just to the decorative laminate itself but to the entire composite element consisting of substrate, adhesive and decorative laminate. The approval is valid only for the specific configuration and combination of composite elements tested.

It is the responsibility of the company processing the composite elements to verify that the specific combination of elements meet the approval requirement for the different fields of application. This may require new testing whenever a change in the composition or configuration of the composite element is no longer covered by an approval. Consideration must also be given to the existence of all new or separate regulations requiring additional approval.

The required approvals and test certificates can be obtained from the manufacturers of the composite elements.

The information sheet "*Fire behaviour of decorative laminates*" summarises the currently valid test procedures in the different countries. This list does not claim to be complete; new test procedures may have been published or old test procedures revised. It is therefore important for the company

processing the composite elements to be familiar with the most recent regulations, particularly if these elements are intended for applications where fire regulations require testing and formal approval. The previously mentioned information sheet also provides information on the relevant approval authorities.

3. Manufacturing the composite units

When processing decorative laminates, the basic principles of the “*General recommendations for working with decorative laminates*” apply. Due to specific features of the production of composite elements with mineral substrates and the stress they are subsequently exposed to, the information in the following sections contains special processing information that must be followed. This applies specially to the environmental conditioning of decorative laminates (see section 3.2). In general, it is necessary to apply decorative laminates from the same manufacturer to both sides of the substrate. It is also recommended to seek advice from the manufacturer of the decorative laminate.

3.1 Substrates

Substrates must have a cleanly sanded surface (thickness tolerance ± 0.3 mm), and they must not have any sanding marks or depressions. If it is not possible to manufacture the substrate with the required tolerances, joint-filling adhesives must be used in order to create a uniformly thick bond layer between the substrate and decorative laminate.

Not all mineral boards are suitable for use as substrates for decorative laminates. For this reason the supplier should be notified of the intended use in order to obtain their recommendation of a suitable product, particularly with regard to thickness tolerance and moisture content.

The internal bond strength of the mineral substrates should be no less than 0.4 N/mm^2 .

Substrate	Typical applications
Expanded mica (vermiculite) board	interior work / ship building
calcium silicate board	public buildings / ship building
fibre-cement board	public buildings / damp locations
cement-bonded chipboard	public buildings / damp locations
gypsum plasterboard	interior work
gypsum fibre board	interior work / public buildings
densified mineral wool board	interior work

Table 1: Overview of mineral substrates

3.2 Conditioning

3.2.1 General information

The first step in minimizing problems associated with dimensional change is to provide adequate environmental conditioning. Poor conditioning will lead to warping of the composite materials and/or to stress cracking after bonding.

Mineral substrates are subject to smaller dimensional changes than wood materials or decorative laminates. Mineral substrates also absorb and release moisture faster, which means it is not advisable to simultaneously condition mineral substrate materials in the same stack as the decorative laminate.

Decorative laminates should be conditioned before processing in pairs and conditioned depending on the selected substrate or field of application. The relative humidity during conditioning should correspond to the environmental conditions of the end-use application as closely as possible. This conditioning is of great importance for processing mineral substrates, but also applies when working with wood materials.

Any protective film must be removed prior to conditioning.

Subsequent changes in relative humidity creates strong stresses between the decorative laminate and the substrate which can result in an increased occurrence of cracks and warping. Mineral substrate materials also have lower peel strength and lower internal bonding strength than most wood substrates, which may increase the possibility of peeling in the uppermost layer of the mineral substrate as well as increased possibility of internal bond failure in the mineral substrate core.

3.2.2 Use in normal environmental conditions

“Normal” environmental conditions are considered to be when relative humidity is moderate to high (50 to 60% RH) and temperature is moderate to low (18 to 23°C) for the majority of the time. Lower humidity and high temperatures may occur only for short periods of time (this also applies to furniture, bathrooms, lavatories, etc.).

The pre-conditioning recommended for these environmental conditions is described in the “*General recommendations for working with decorative laminates*”. The decorative laminates should be stored in pairs (reverse side against reverse side) at normal environmental conditions of 23°C ± 2°C, 50% ± 10 % RH, for three days and then processed in pairs.

The supplier should use only pre-conditioned mineral substrates with a moisture content of 6 to 10% (4 to 6% for vermiculite boards). The mineral substrates, like the decorative laminates, should be stored at normal room temperature environmental conditions (see above) for at least 3 days.

3.2.3 Use in continuous low humidity conditions

The recommendations in this section should be followed for applications with continuous low relative humidity and/or elevated temperature (e.g., warm heated air near radiators or in ventilation shafts). It is very important to pre-condition the decorative laminates under environmental conditions which are as close as possible to the low humidity of the end-use application. This reduces the potential for shrinking and stress in the finished part.

It is recommended that the decorative laminates be conditioned in pairs (reverse side against reverse side) in an oven with circulating air (fan oven) for:

- 20 hours at 40°C or
- 10 hours at 45°C or
- 5 hours at 50°C or
- 3 hours at 55°C

Uniform circulation of the conditioned air around each pair of boards is important (see Fig. 1). Conditioning in a closely packed stack without sufficient spacing will produce unacceptable results.

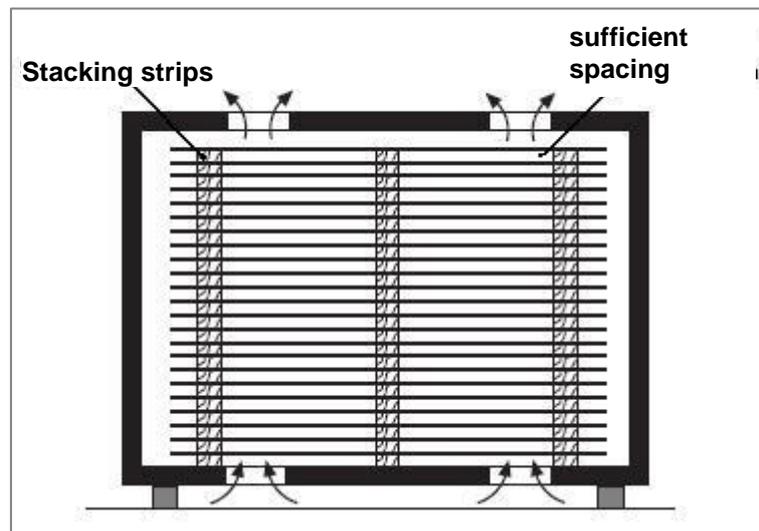


Fig. 1: Diagram of conditioning decorative laminates in pairs

Bonding must be performed immediately after conditioning and, if required, after allowing sufficient time for the parts to cool to room temperature. It is critical to verify that the composite elements manufactured with decorative laminates pre-conditioned in this manner will not be subsequently used in areas with continuously high humidity.

Where it is impossible to immediately bond the conditioned decorative laminates, it is recommended that re-absorption of the moisture be prevented by wrapping the decorative laminates with a barrier with low water vapour transfer properties (e.g. aluminium sheet or special grades of polyethylene film)

upon removal from the circulating air oven. The water vapour barrier should be left in place until immediately prior to bonding to the substrate.

The mineral substrates for use with continuously low humidity should be pre-conditioned separate from the decorative laminate.

3.3 Adhesives

Table 2 shows suitable adhesives. It contains the mineral substrates and adhesives which were in common use at the time this technical leaflet was created. The adhesive manufacturer should be consulted for advice on proper adhesive selections and to assist in bonding trials.

It is important to ensure that the adhesive selected does not affect the fire behaviour of the composite element. Fire behaviour, type and composition of the substrate, and the intended end-use application may limit the adhesives suitable for bonding decorative laminate to mineral substrates.

Note: Contact adhesives are NOT recommended for bonding decorative laminates to mineral substrates.

Substrate material / adhesives	Dispersion adhesives	Condensation resin adhesives	Reactive adhesives	Hot melt adhesives
expanded Mica (Vermiculite) boards	+ ^{rec}	+ ^{nr}	+ ^{rec}	+ ^{rec}
calcium silicate boards	+ ^{rec}	+ ^{nr}	+ ^{rec}	+ ^{rec}
fibre-cement board	-	+ ^{nr}	+ ^{nr}	+ ^{nr}
cement-bonded chipboard	-	+ ^{nr}	+ ^{nr}	+ ^{nr}
gypsum plasterboard	+ ^{nr}	+ ^{nr}	+ ^{nr}	+ ^{nr}
gypsum fibre board	+ ^{nr}	+ ^{nr}	+ ^{nr}	+ ^{nr}

Table 2: Suitability of adhesives

Table 2 Key

Adhesives	Pre-treatment
+ possible	^{req} required
- not possible	^{rec} recommended
	^{nr} not required

3.4 Surface treatment

The surface of some mineral substrates must be pre-treated before bonding following the recommendations of the adhesive manufacturer (see table 2). It is possible that pre-treatment will

change the moisture content of the mineral substrate, therefore is recommended to perform post-conditioning. This substrate pre-treatment provide the following benefits:

- a. Solidifies the surface,
- b. Prevents excessive sinking of the adhesive into the substrate,
- c. In certain cases, allows for modifying the pH value of the surface to the adhesive used.

3.5 Bonding

Details about bonding technology and pre-treatment for bonding decorative laminates on mineral substrates are shown in technical leaflet "*Gluing Table for High Pressure Laminates*". Contact the panel manufacturer for additional recommendations on substrates. Contact the adhesive manufacturer for additional recommendations on bonding.

3.6 Hot melt adhesives

The most common hot melt adhesives used are PUR based adhesive systems. For proper bonding a minimum substrate temperature of 20°C and a minimum relative humidity of 40% is required.

A current and detailed overview of the use of adhesives for decorative laminates can be found in the technical leaflet "*Gluing Table for High Pressure Laminates*".

4. Bonding methods

Conventional bonding equipment can be used for bonding decorative laminates to mineral substrates, such as glue spreading machines with two or four rollers, automatic spray guns for two-component PUR adhesives, and presses with one or several openings for hot or cold pressing. Vacuum presses can also be used. Hot melt adhesives are applied mainly using roller coater systems.

4.1 Adhesive application equipment

The most common equipment is adhesive application machines with two rollers. Even though they do not produce as high a quality coated surface as systems with four rollers, they are still suitable for most bonding processes. Glue application machines with four rollers produce a significantly better coated surface and the adhesive film can be applied within a very narrow tolerance range.

Other application methods such as manual spreading devices or hand spray guns can also be used.

4.2 Presses

Multi-level cold presses, sometimes referred to as stack presses or multi-opening presses, are the simplest form of a platen press. They feature a hydraulically operated press head or press table.

Single-level or multi-level hot presses are equipped with heatable platens. Heat is supplied using water, steam or oil, with the latter allowing the best and most constant temperature control.

Vacuum presses can also be used for bonding, however, only cold-curing adhesives can be used. The low bonding pressure, typically a maximum of 0.8 bar (80 kPa) is a disadvantage.

5. Machining

Due to the high wear on cutting tools caused by composite materials that contain mineral substrates, suitable cutting tools have to be selected for machining. It is particularly important that all machined edges are free from nicks and cracks. Cut-outs must be rounded off and drilled holes must be appropriately oversized (see technical leaflet "*General recommendations for working with decorative laminates*".)

Material particles and dust caused by machining must be thoroughly removed to avoid scratching the surface of the decorative laminate.

Note: National environmental and health and safety requirements for processing mineral-containing materials must be followed. This also applies to composite elements made of decorative laminates using mineral substrates.

6. Design recommendations

When the conditions at the end-use application will subject the composite elements to dynamic loads through warping or moving (e.g., in ships or vehicles), sufficient clearance for movement should be provided during installation. This allows room dividers (e.g., in ship's cabins) to be fixed to floor and ceiling using suitable brackets. Suitable edge profiles allow sufficient clearance when mounting several plates side by side. The edge profiles should be interlocking because of the low internal bond strength of the mineral substrates.

Where interlocking edge profiles are not possible for design reasons it is possible to work with groove and loose tongue, with the depth of the groove not exceeding half of the thickness of the mineral substrate board. If fire regulations require the tongue to be wider, the depth of the groove should be kept as small as possible in order to prevent the substrate splitting.

If high dynamic loads are expected, the composite elements have to be reinforced at the back side at shorter intervals.

Where moisture could possibly act on the edges of the composite elements, the edges must be protected with water-proof coatings before installation.

7. Attachment

Composite elements made of decorative laminates and mineral substrates are typically used in areas where fire regulations apply. Therefore, attachment methods and attachment materials must also comply with these fire regulations.

Where composite elements are used as wall and/or ceiling coverings, the area underneath has to be sufficiently dry. Composite elements can be used for partition walls, free-standing in steel frames.

Special attention must be paid to the connections between the individual elements. This applies to horizontal and vertical connections. Joints can have a significant influence on fire behaviour; regulations concerning the selection of connection materials must be followed. Regardless of the selected attachment method, the spacing between the attachment points should be determined in accordance with the substrate, the thickness of the composite element, and the bearing load. For screw attachment methods, the selected screw types must be suitable for the respective substrate.

7.1. Attachment options

There are many different options for attaching composite elements made of decorative laminates and mineral substrates to each other and to building components. They can be divided into four categories:

1. Invisible adhesive connections
2. Visible mechanical connections
3. Combination of invisible adhesive connections and visible mechanical connections
4. Invisible mechanical connections

7.1.1 Invisible adhesive connections

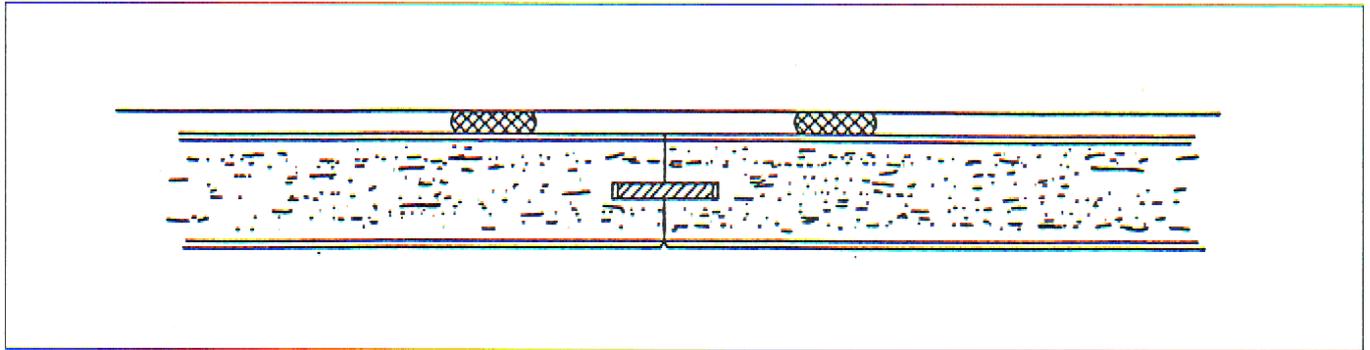


Fig. 2: Double-sided adhesive tape with expanded carrier material

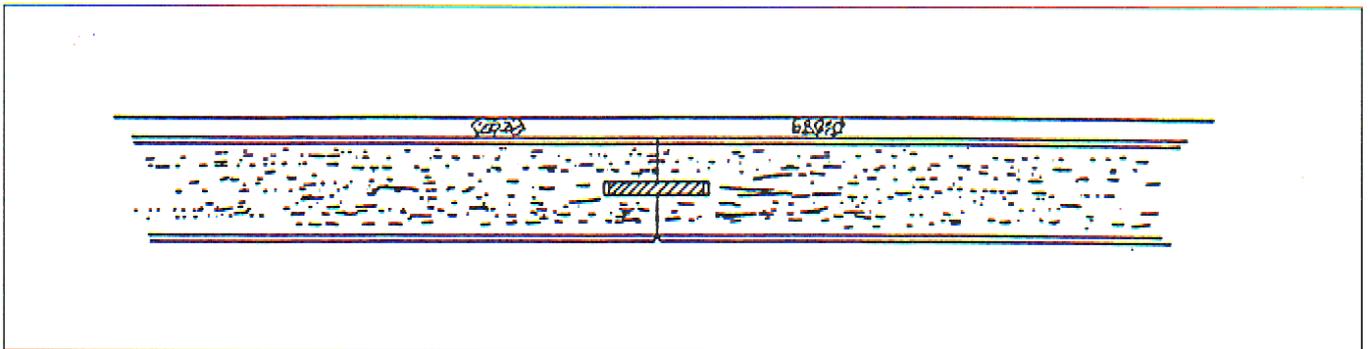


Fig. 3: Elastic construction adhesives

7.1.2 Visible mechanical connections

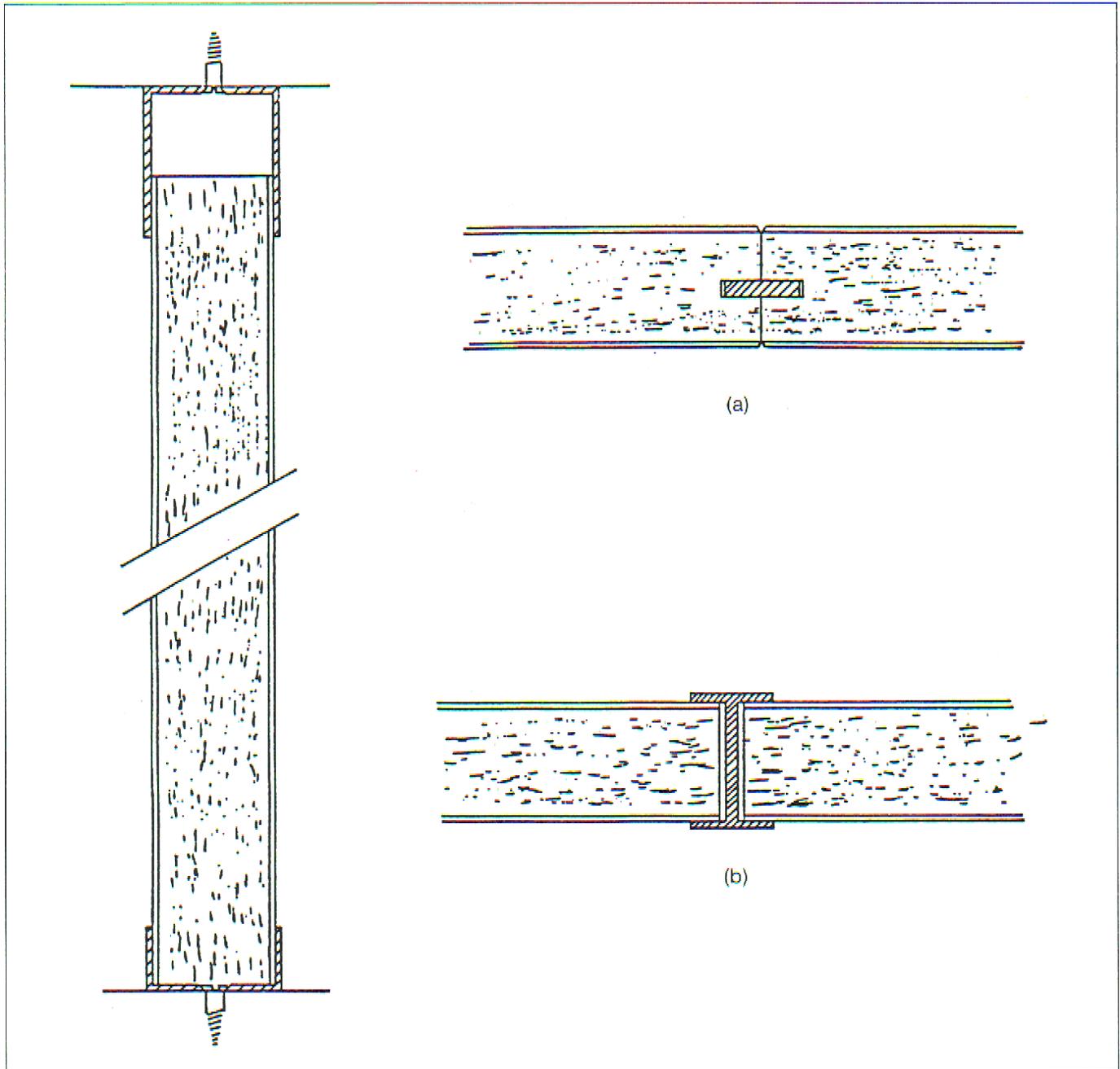


Fig. 4: U-profile (left), with loose tongue (a) or with H-profile (b) in the joints

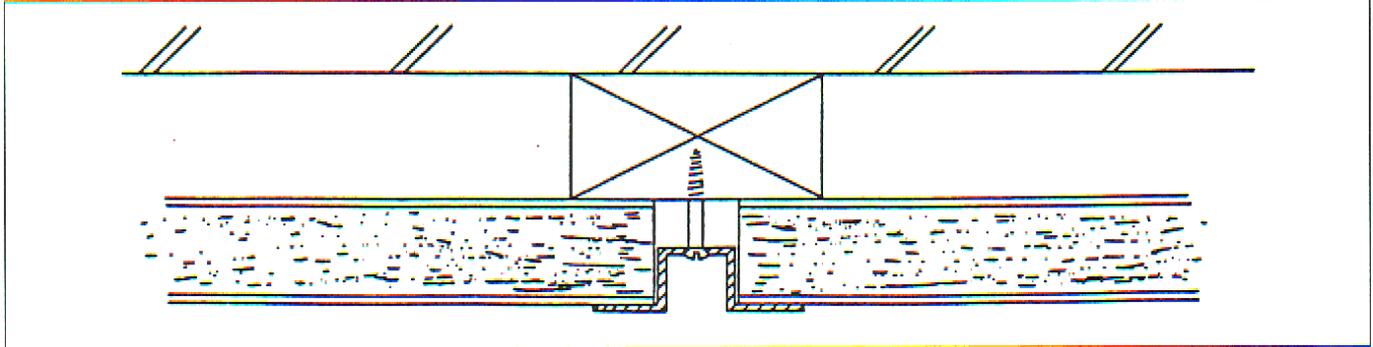


Fig. 5: Omega profile, screw-fixed to the substructure

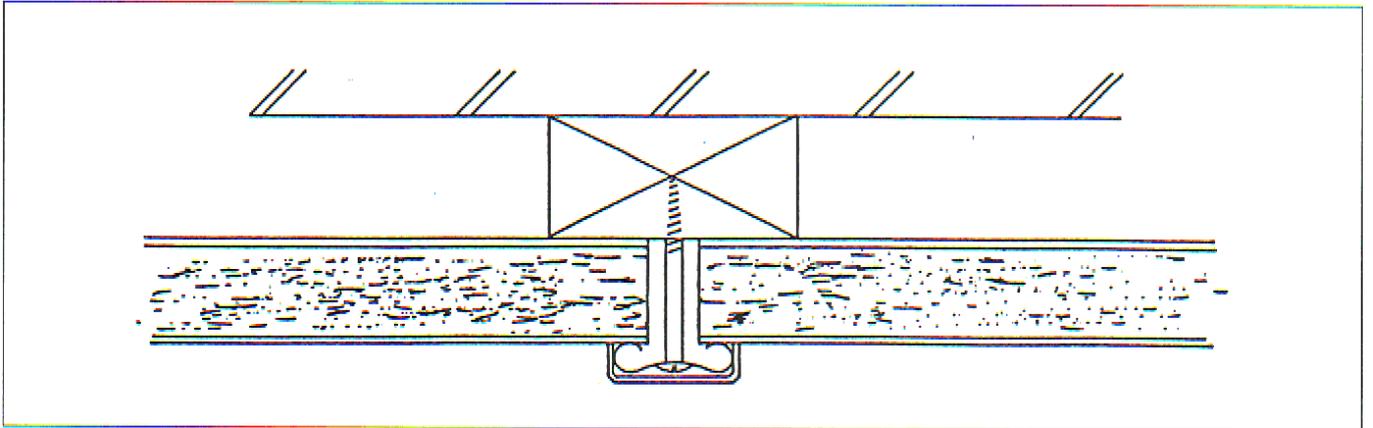


Fig. 6: Metal clamps, screw-fixed to the substructure and covered with a profile

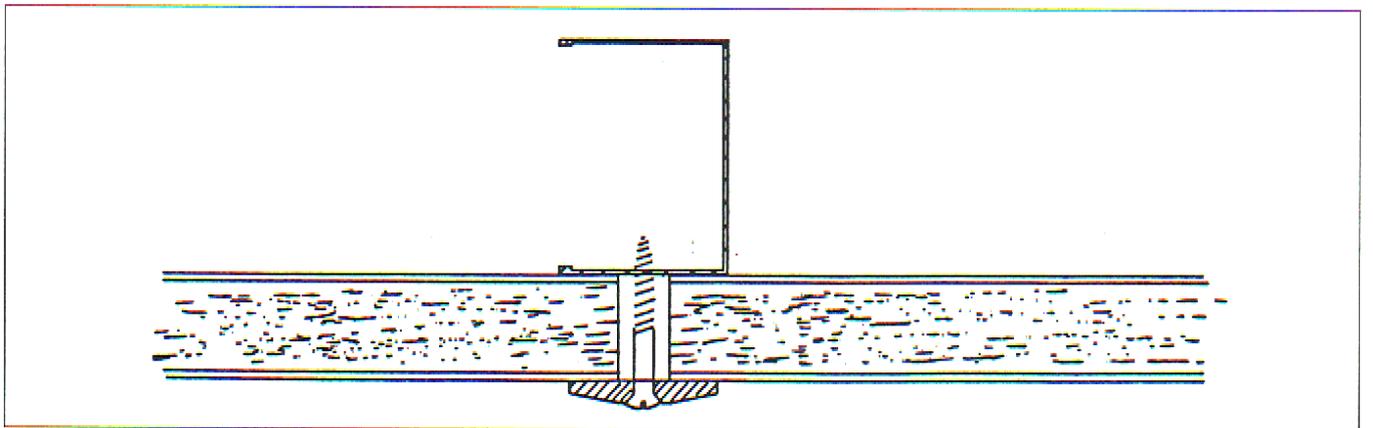


Fig. 7: Cover profile, screw-fixed to the substructure

7.1.3 Combination of invisible adhesive connection and visible mechanical fixing

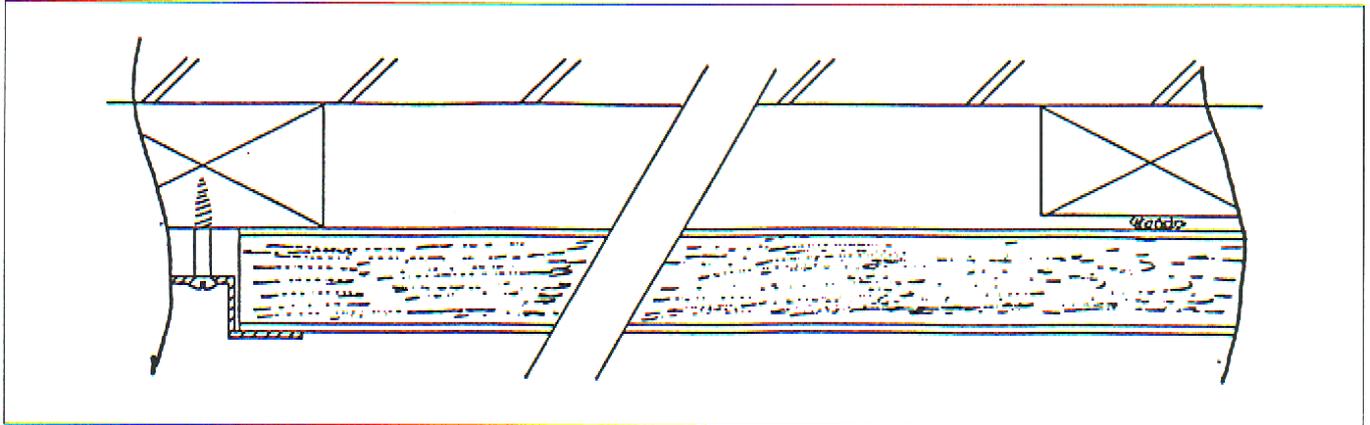


Fig. 8: Left: Omega profile, screw-fixed to the substructure. Right: Glued to the substructure with elastic construction adhesives

7.1.4 Invisible mechanical fixing

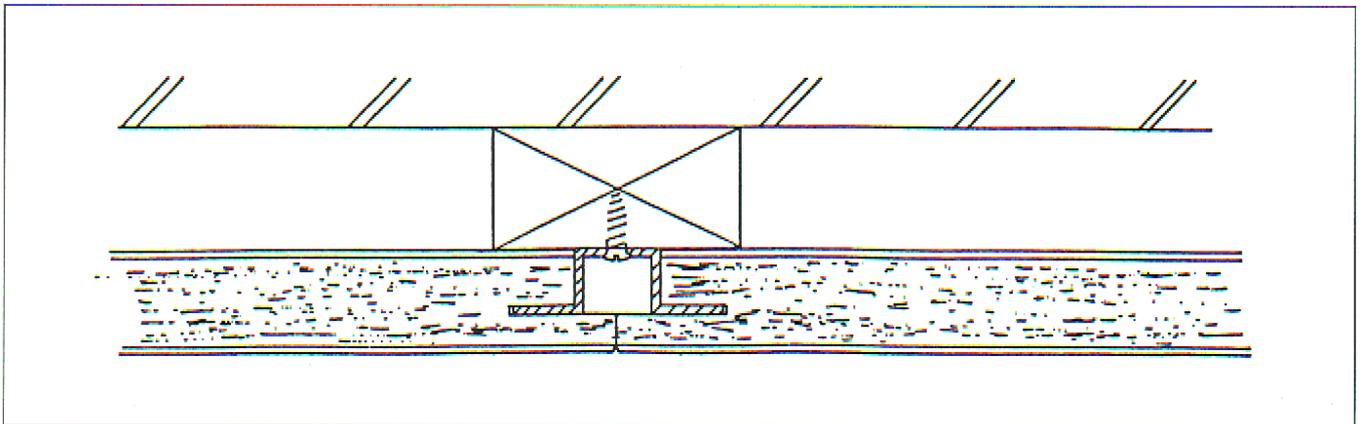


Fig. 9: Omega profile, with tongue and groove set into the joint edge and screw-fixed to the substructure; tight joint

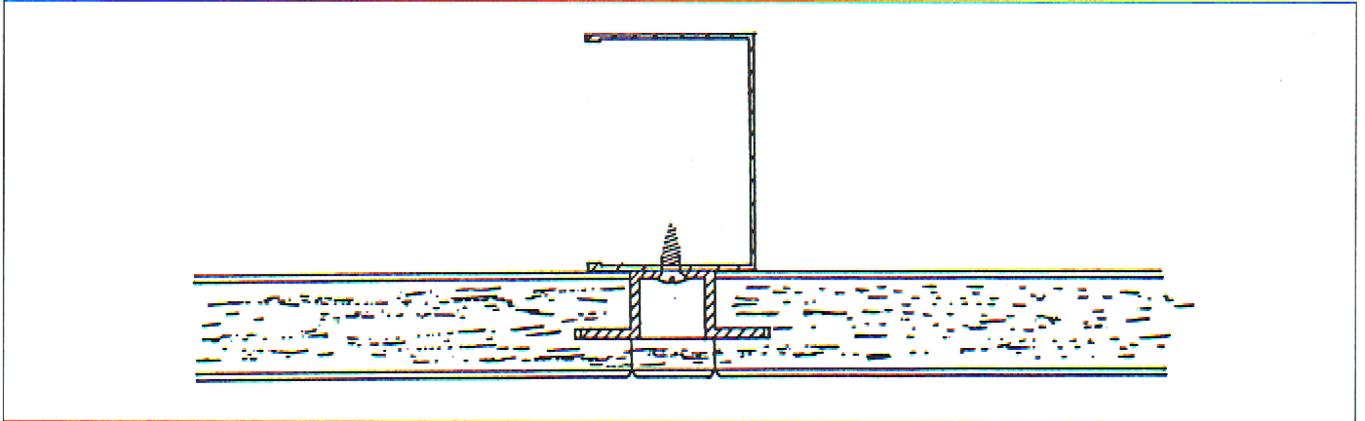


Fig. 10: Omega profile, with groove set into the joint edges and screw-fixed to the substructure; joint opening covered by a flush set strip

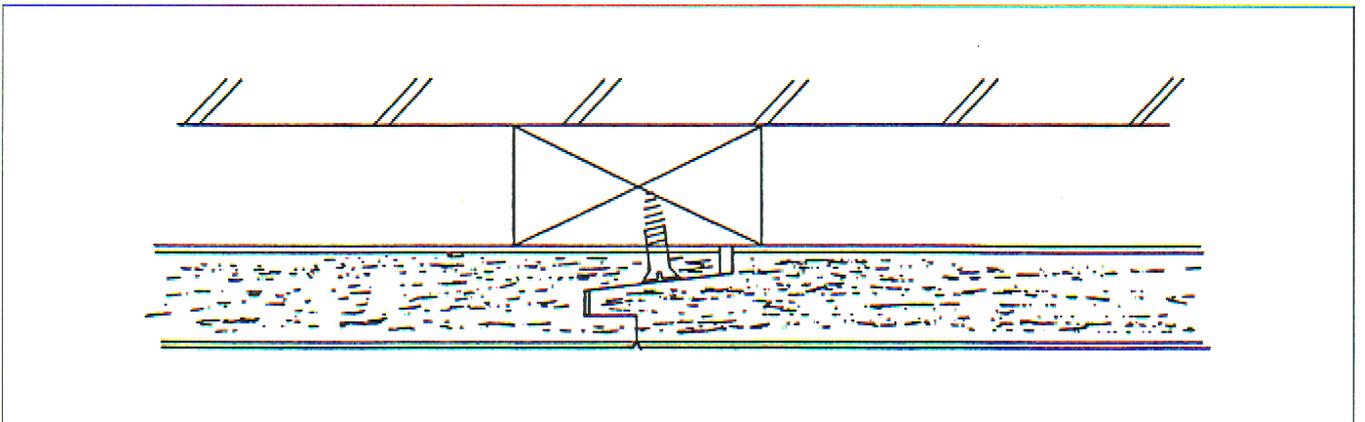


Fig. 11: Screw-fixed with a suitably profiled element edge on the substructure

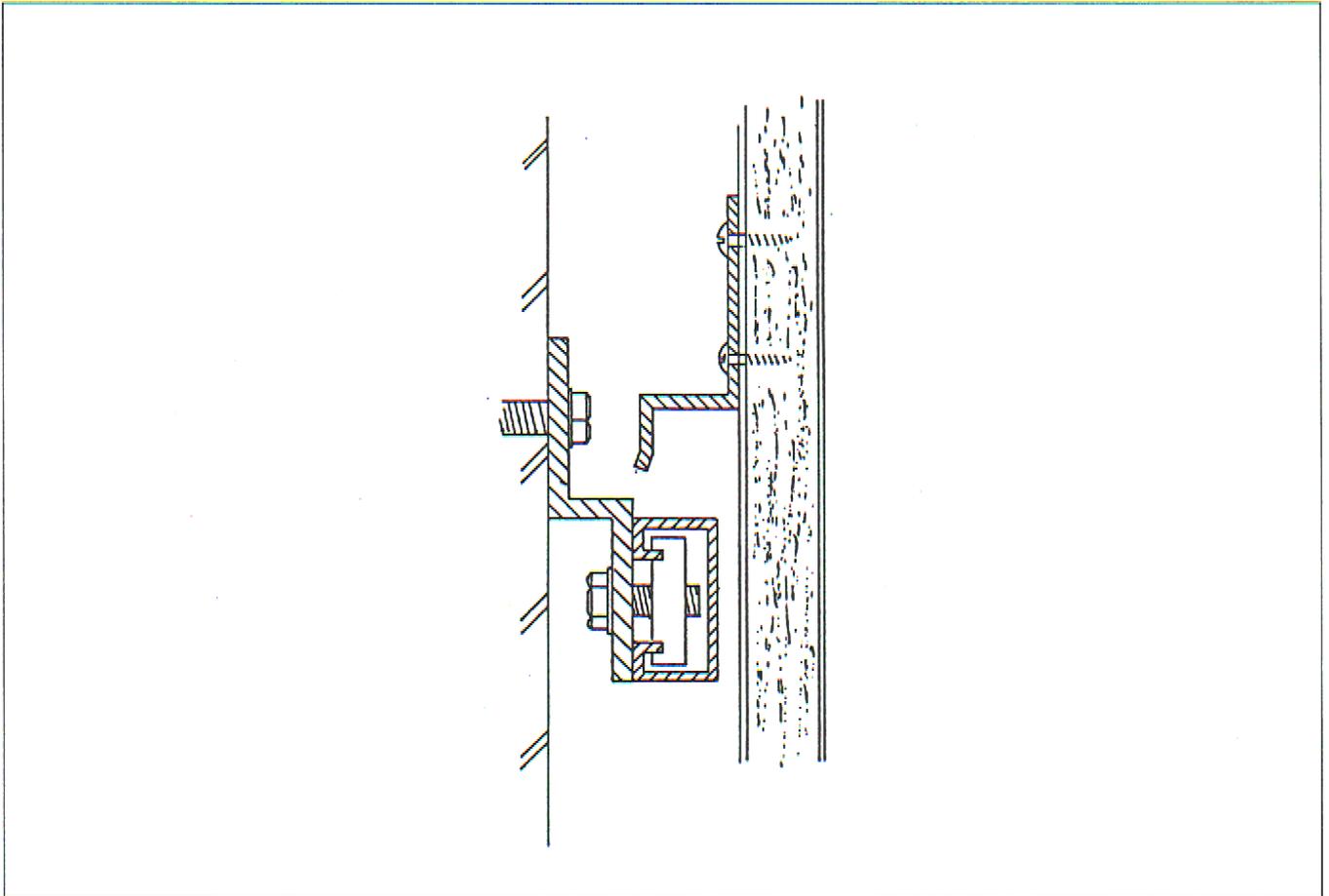


Fig. 12: Horizontal metal construction, screw-fixed to the composite element with Z hooks

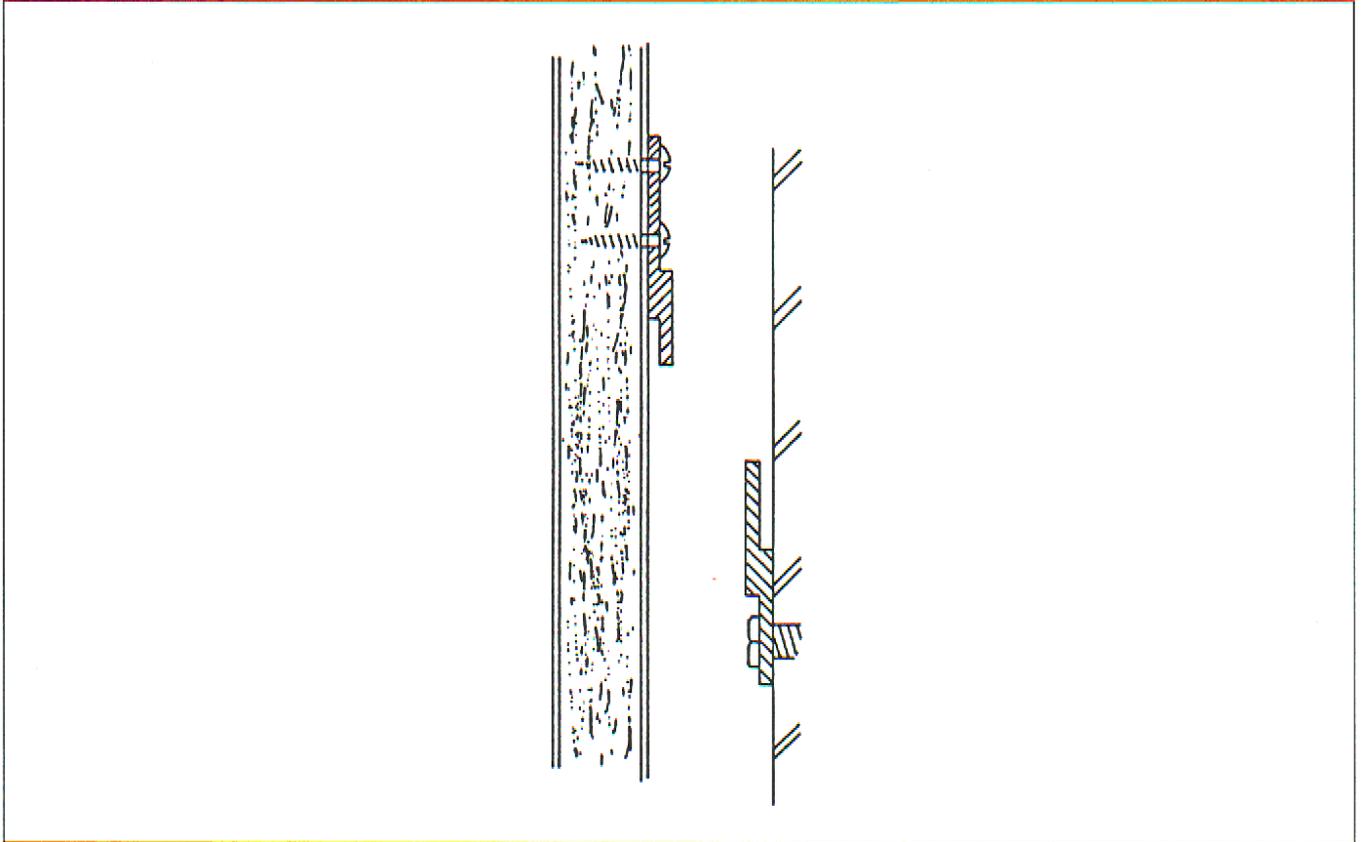


Fig. 13: Metal Z-profile

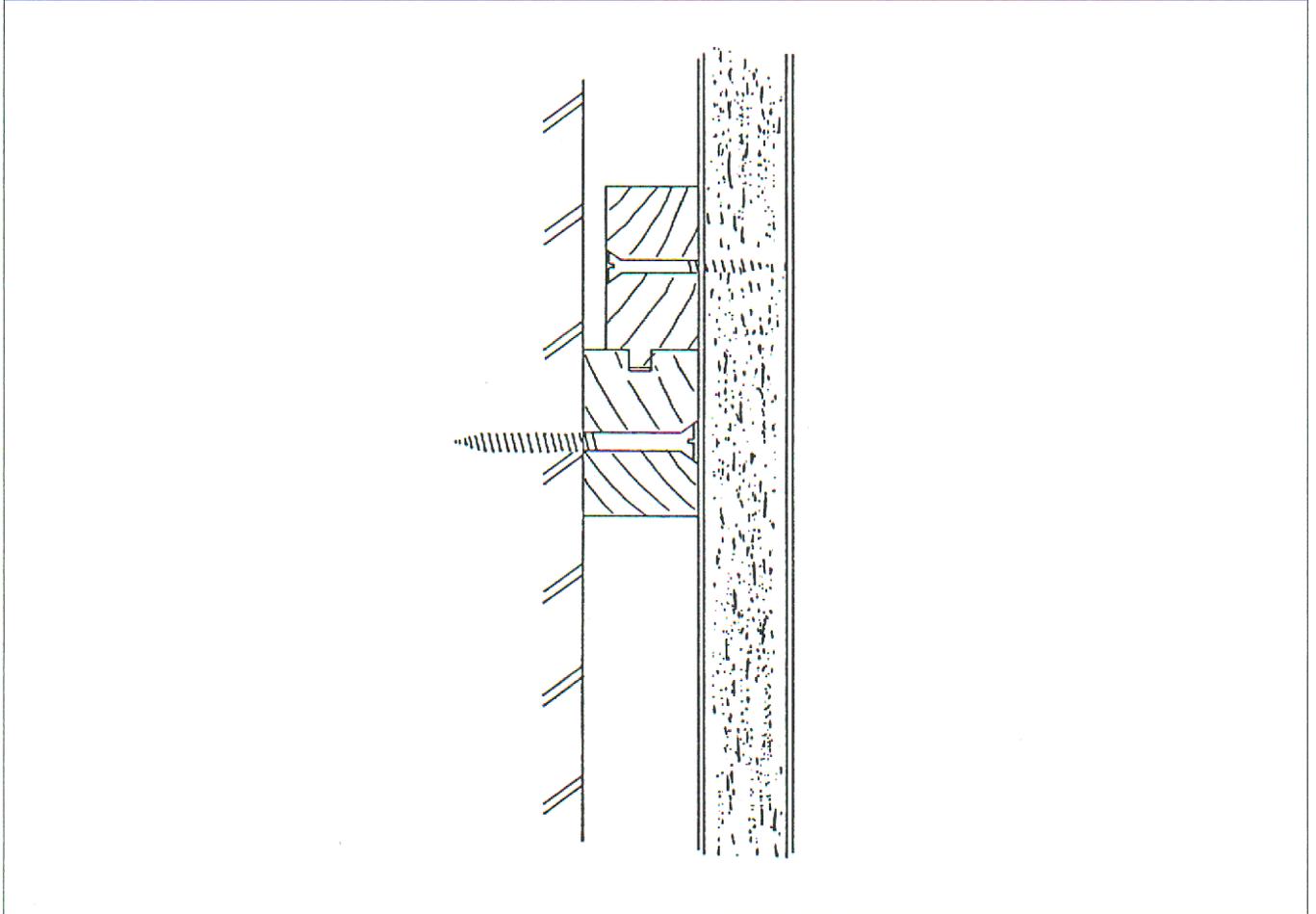


Fig. 14: Matching tongue and groove strips

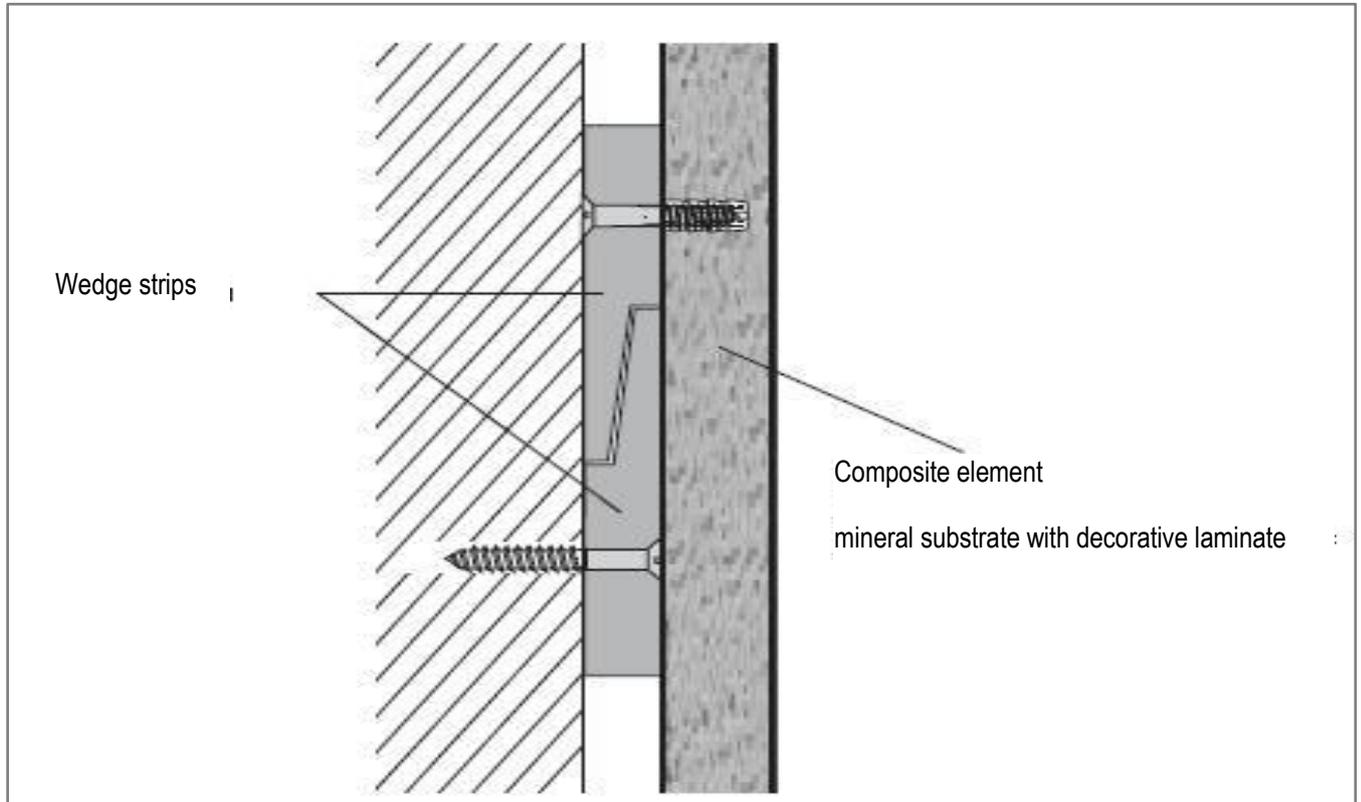


Fig. 15: Fixing with wedge strips

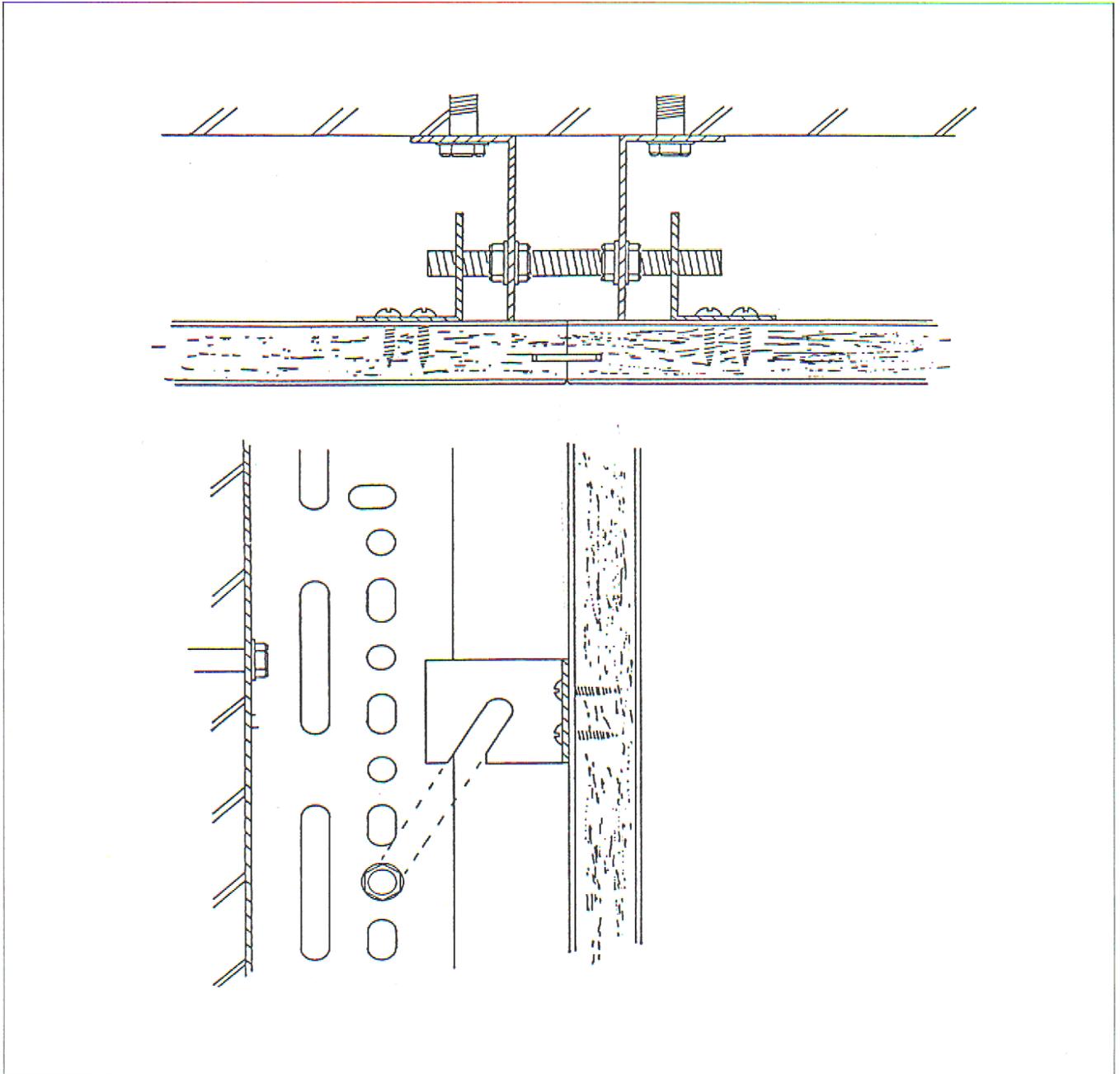


Fig. 16: Vertical metal construction, screw-fixed to the back of the composite element with angled hooks