

*Tunnels and  
underpasses*

VITREOUS ENAMEL



*tecnosmalto group*

## VITREOUS ENAMEL

Tecnosmalto Group srl designs and supplies panels made of vitreous enamel to building sites. The company supplies different types of panels in a wide range of colours (even specifically requested colours), which differentiate themselves for their exceptional mechanical, aesthetic and chromatic characteristics, in compliance with the most demanding technological criteria. The vitreous enamel panels are produced in the shapes required by customers and enamelled in the desired colours, to carry out wall covering for tunnels and underpasses.

### Vitreous enamel

Vitreous enamel is an inorganic coating material with a composition that is vitreous in nature. After applying it by electro-static spraying it onto a metal object's surfaces it is fired in an oven at extremely high temperatures (circa 830°C). During the firing the enamel fuses and coats itself perfectly onto the metal support, thereby originating a new material called vitreous enamel, which has exceptional chemical and physical characteristics.



### Supporting structure

The supporting structure for the panelling can be made of AISI 304 stainless steel profiles, galvanized steel or omega aluminium shaped profiles, calendered in the required range, placed at defined distances and anchored to a tunnel's walls using threaded stainless steel bars of a suitable diameter and fixed into place using epoxy resin, or if the environment is humid, using mechanical wedges. The panel plates must be mounted in close proximity and riveted onto the sub-structure. In order to close the gaps between the panels, stainless steel or aluminium lap plate profiles must be used. For covering the walls of pedestrian underpasses, which is carried out using box type panels (folded on all four sides), a metal supporting sub-structure with tubes with pivots for hooking the panels must be used. This system permits covering walls without using lap plate profiles.

### The covering of walls in tunnels and underpasses

The covering of walls with vitreous enamel panels permits satisfying today's more demanding technical and performance requirements, both in terms of safety and duration. Vitreous enamel produced in panels is without doubt an excellent alternative to other materials used in the past (ceramic tiles, painted plates, plastic slats, polycarbonate sheets, fibre cement etc) which are nevertheless useful materials. The reasons this material is an excellent alternative are the following:

- if water drips onto the material it will not disintegrate when there is a frost.
- it has an unlimited duration and is easy to wash thanks to the hardness of the vitreous enamel.
- it is fireproof and does not emit toxic or harmful gases if there is a fire in tunnel.
- it is easy to install, requires very little maintenance, and if damaged by accidental blows each individual panel can be replaced.
- the colour does not fade in time.



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### Wall covering with slab panels

Panels made from flat steel sheets with low carbon levels (decarburized), cut to the right size and with holes in the vertical edges for fixing the supporting sub-structure. The thickness of the steel sheets normally depends on the size of the plates. For vault covering we recommend a thickness of 15/10. For covering walls with curved sections we recommend a thickness of 25/10.

- maximum size of sheet metal panels: 1500x4000 mm.



### Wall covering using panels with folded edges

- Panels made from decarburized steel sheet, 15/10 in thickness, with their edges folded outwards, the corners welded and bevelled, complete with holes for fixing the hooking plates to a sub-structure.
- Plating used for stiffening using 10 mm thick anhydrite sintered or calcium silicate plates stuck to the porcelain coated steel panels using polyurethane glue.
- Balancing of the panels is carried out using 8/10 thickness galvanized steel, or other materials, applied by gluing them to the stiffening plates under pressure.
- Maximum size of panels with edges: 1450x3500 mm.



### The enamelling

The enamelling of raw panels is carried out in conformance with the new UNI EN 14431 standard for architecture, using "A" or "AA" class acid and/or chemical resistant enamels, in the colours requested by customers. They cannot be altered in structure or colour by the effects of atmospheric and/or chemical agents. Once the mechanical work has been completed, the raw panels are subjected to a degreasing and pickling treatment. The enamelling technology we use is the traditional type that consists in the application of a bottom layer (the grund) and then a first firing in an oven. After this, two layers of coloured enamel are applied and fired at a temperature of circa 830°C.

- the thickness of the enamel applied to the visible external surfaces is: >220 micron.
- the thickness of the enamel applied to the internal surfaces is: >100 micron.

### Increase in brightness

The covering of walls using vitreous enamel panels or other brightening materials ensures the attainment of a good increase in brightness inside tunnels, and therefore the attenuation, which increases safety, of the psychological discomfort that drivers of vehicles feel when they pass from the light of day to the semi-darkness of tunnels. The covering using vitreous enamel panels is believed to be more suitable than covering the walls using other materials because of its exceptional qualities in terms of resistance to abrasion and scratches (when the surfaces are washed-down), the inalterability in time of the colour and their initial shine.

### Resistance to atmospheric and photochemical agents

Vitreous enamel has a very high resistance to atmospheric agents: the polluting substances in the air, acid rain, marine atmospheres, sunlight, temperature ranges, and the carbon residues left by vehicle exhaust gases do not effect enamelled surfaces, which therefore maintain their colour and initial lustre over time.

### Resistance to temperature change

Temperature changes ranging from a minimum of -50°C and a maximum of 450°C do not alter the chemical and physical characteristics of objects made of vitreous enamel. Heat and direct flames do not in the least damage enamelled surfaces.



### Protection in case of fire

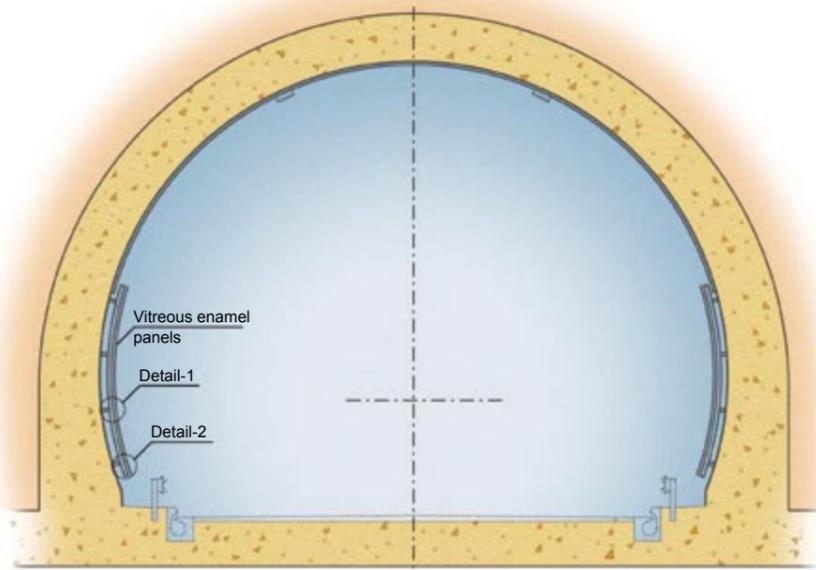
If there is a fire, vitreous enamel installed leaving a space of circa 30 cm from a tunnel's walls ensures good protection of the main structures and systems located in the spaces. Vitreous enamel does not give an increase of inflammable mass since it is fireproof (class zero). If there is a fire there are no emissions of toxic or harmful gases.

### Resistance to vandalism

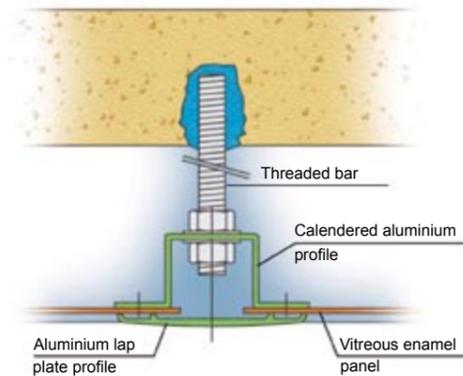
Walls covered with vitreous enamel panels perform well in resisting vandalism carried out with penknives, screwdrivers, keys, spray cans, felt-tip pens, paint, stickers etc. Scratches and other fouling in general can easily be removed with solvents or detergents without rings or traces of dirt remaining. These panels are cleaned by brushing them using specifically equipped vehicles.



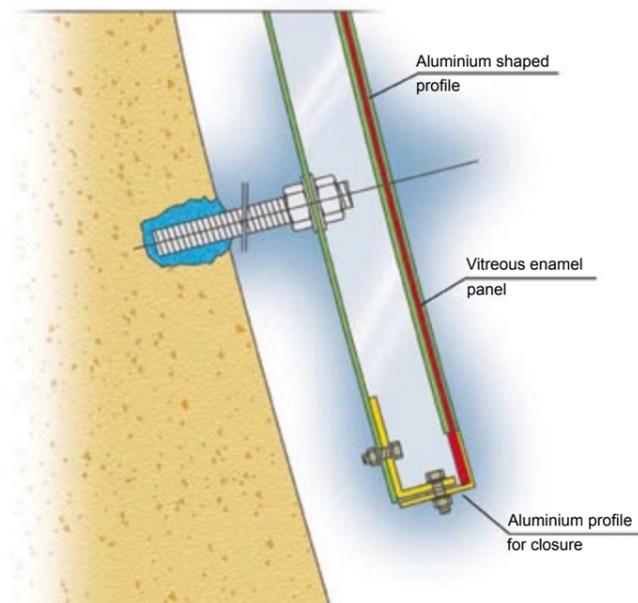
## VITREOUS ENAMEL



Typical tunnel section



Detail-1



Detail-2

### Resistance to aggressive chemicals

The vitreous surfaces of vitreous enamel is not affected by aggressive chemicals such as organic solvents, saline solutions, base elements, paint, detergents, oil, fats, and most acids.

### Resistance to corrosion

During firing at 830°C the enamel fuses and fuses completely onto metal supports, thereby avoiding the possibility of oxidation even at high temperatures.

### Photo-luminescent panels

Tecnosmalto supplies aluminium slow emission photo-luminescent panels. These panels are made using extruded enamelled profiles with class "A" acid resistant enamels. These panels have continuous low grooves in which photo-luminescent and high efficiency enamel with a low emission of photons is deposited, in accordance with the DIN 67510 standard. The panels can be installed on the walls of tunnels, thereby assisting passing motorists.



### Special Serigraphs

Vitreous enamel panels may be printed on, therefore also being used as decorations, for the communication of information and for architectural reasons. With serigraph techniques it is possible to reproduce brand names, drawings, artistic objects and colour photographs.



### Reference standards and conformity tests

- UNI 5717/ISO 2722 citric acid resistance tests
- UNI 6725 resistance to blows tests
- UNI EN 154 abrasion resistance tests
- UNI ISO 2178 determination of the applied enamel thickness
- UNI 8883 tests for the adherence of enamel to metal supports
- UNI 7883/89 test for uniformity of enamel layers to high tension electricity discharges
- UNI 9613/ISO 4522 resistance to blows tests
- UNI 5687/73 salt spray (500h) corrosion resistance tests
- UNI 7674 temperature change resistance tests
- UNI ISO 8290 sulphuric acid resistance tests

	vitreous enamel	ceramic tiles	pigmented cement fibre	pre-painted aluminium	concrete slabs	painting
Refractoriness	***	***	**	**	***	✓
Ability to reflect light	***	***	**	***	**	✓
Behaviour at high temperatures	***	**	*	-	**	**
Emissions of toxic gases	absent	absent	low	low	absent	low
Ease of cleaning	***	***	*	**	✓	*
Resistance to blows	**	*	✓	**	**	**
Duration	***	***	**	**	*	✓
Recyclability	**	✓	*	***	*	-
Purchasing price	medium/high	medium/high	medium	medium	medium/high	low
Maintenance cost	low	high	medium	medium	medium/high	high

\*\*\* excellent \*\* good \* adequate ✓ poor - inadequate



Tecnosmalto Group s.r.l.  
Via Redipuglia 5/A - 20010 Bareggio (MI) Italy  
Tel. +39 02.9143.8809 / +39 02.9143.8810  
Fax +39 02.9143.8811  
[www.tecnosmalto.it](http://www.tecnosmalto.it)  
[info@tecnosmalto.it](mailto:info@tecnosmalto.it)