THE MÜLHEIM/RUHR METRO

Building two stations of the Metro system in Mülheim/Ruhr, Germany, provided an opportunity to use installation systems that guarantee top quality results.

by Andreas Poitz

Increasing traffic in metropolitan areas has led many cities to build underground mass transit systems. Designing an infrastructure that can absorb a large flow of passengers involves creating interior spaces that must be not only highly functional but attractive enough to distract passengers from potentially negative feelings induced by being underground. The stations must be designed to have a positive emotional impact through visual elements that:
- safely channel the flow of passengers;
- provide quick access to platforms;
- define hazardous areas (platform edges).

When the basic elements of form, light and color are harmoniously combined, all of these prerequisites can be satisfied. The intelligent use of products and materials is essential for the final effect. Besides steel, glass, concrete, brick and various synthetic materials that are often used structurally, floor and wall coverings in ceramic tile and natural and semi-natural stone are widely used for decoration.

Technical prerequisites

A fundamental prerequisite for building the Metro project was bonding floor and wall coverings, screeds, plaster and leveling compounds to the bearing structure securely and durably. When using "noble" materials such as natural or semi-natural stone, there are some purely technical aspects to be taken into consideration, such as their tendency to discolor or potential dimensional instability. For this reason high quality setting materials are needed that:
- can be used even at low temperatures for faster completion times;
- prevent water from seeping in from the bearing structure;
- stand up to heavy passenger traffic;
- resist chemical cleaning products.

Mapei has developed a series of products that meet these prerequisites, from the substrate on up. A significant example of the application of this cycle of high performance products is the Metro line in Mülheim/Ruhr, Germany.

Better bonding

Because they are built in the early stages of construction, substrates are frequently not suitable for the kind of flooring to

be installed over them much later on. Flooring needs special substrate preparation that is determined by the building materials used and the covering to be installed over them. In the Mülheim/Ruhr Metro the screeds were bonded to the concrete substrate with PLANICRETE*, a synthetic latex that improves bonding to all surfaces when added to cement-based mixes. It makes concrete more watertight and increases flexural strength and resistance to freeze-thaw cycles (Photo 1, page 18). PLANICRETE was also used as a bonding slurry. Various cementitious adhesive systems were used in the Mülheim/Ruhr Metro stations, depending on the type of floor or wall covering: GRANIRAPID, ADESILEX P9 and KERAFLEX*.

Living materials

Stone is often used as a design feature in Metro stations. It

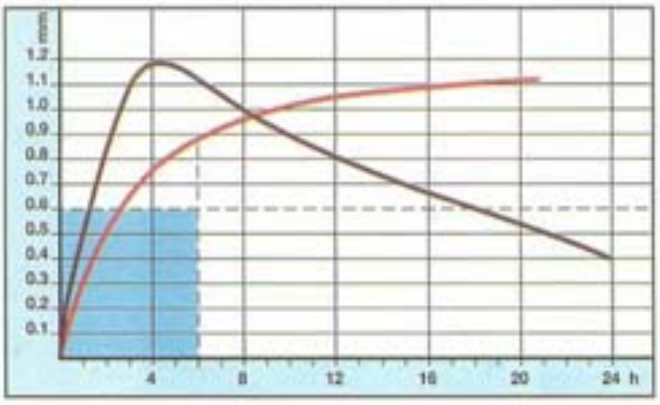
seems to have a life of its own, as can be seen when it is installed: it can discolor, stains can appear on the surface, and dimensional instability can result in cracking or warping. This is caused by the moisture that acts on the back of the slabs during setting.

In order to avoid damaging these materials Mapei has not only developed safe, high performance products but even a method of determining to what degree each variety of stone is sensitive to moisture. A simple, precise test indicates the deformations caused artificially on stone over time. Over 1,200 types of stone were tested with this method and were subdivided into three different groups according to their degree of sensitivity.

It was also found that materials of the same type can vary in behavior when originating from different quarries or in different stages of evolution. The setting method recommended for preventing defective installations can be determined according to the grouping. Besides physical behavior, the Mapei Research and Development laboratories also analyzed the crystal structure of individual types of stone: the grain of the stone's crystal structure and its color turned out to be important criteria for measuring dimensional stability and the tendency to discolor.

These analyses enabled Mapei to offer the best setting methods for the Mülheim/Ruhr installations even in the difficult climatic conditions of underground construction. After preparing the substrate as described above, GRANIRAPID was used to set the Rosa Forte, Bianco Cristal and Branco Perola granite on the floors and walls (Photo 2). GRANIRAPID is a fast-setting and hydrating two-component adhesive system developed in the Mapei Research and Development laboratories that is ideal for setting even large slabs of moisture-sensitive materials like natural stone that require a fast drying adhesive.

Warping in stone/time



Not just for stone

A bond coat of PLANICRETE was applied over approximately 400 square meters (4,300 sq ft) of sanded concrete walls and columns, followed by a coat of NIVOPLAN leveling mortar. (Photo 3). PRIMER G was then applied, over which mineral fiber panels (Photo 5) were installed. PRIMER G is a synthetic resin-based water-dispersion primer that improves bonding. (Photo 4). These panels were then covered with 5x24 cm (2"x9.5") glazed ceramic tiles using ADESILEX P9, a powdered cementitious super-adhesive. When mixed with water, ADESILEX P9 forms an easily worked, very thixotropic mortar with high bond strength that can be applied on vertical surfaces without running or sagging.

KERAFLEX was used to set the 11.5x24 cm (4.5"x9.5") clinker on the floors. KERAFLEX is a ceramic tile adhesive whose high bond strength and moderate flexibility make it ideal for installing flooring subject to heavy stresses like those in the Metro stations (Photo 6).

Grouted granite

Planning expansion joints and the proper grouting of the joints complete the look and determine the ultimate strength of the covering. Floor and wall coverings in metro stations have various performance requirements: the choice of a material, where it is used, and the stresses the material must bear, are the decisive factors in designing the performance profile of the grout. Generally metro station installations need grout that:

- has high mechanical strength;
- is stain-resistant;
- is color-stable;
- bonds strongly to the tiles;
- resists high strength detergents;
- is flexible;
- is fast drying and hardening:
- can be used for floor and wall covering of various sizes.

All of the materials installed in the Mülheim/Ruhr Metro stations were grouted with ULTRACOLOR because it meets all of the above requirements (Photos 7 and 8).


PHOTO 1


PHOTO 2


PHOTO 3


PHOTO 6


PHOTO 4


PHOTO 5

Colorful vaulted ceilings

Plaster is an essential design ingredient in the vaulted ceilings used in Metro systems, especially in the Mülheim/Ruhr Metro where plaster was used in some places as a finish and in others in combination with soundproofing systems.

A waterproofing membrane and a flexible waterproofing paint were used to solve the usual problem of bonding the rigid plaster and combating its natural tendency to soil quickly (plaster often has a rough surface that traps dirt). After removing the traces of cement laitance and loose particles by sandblasting, the surfaces were treated with MAPELASTIC*. This product's easy pumpability enabled it to be pumped through 25 mm hoses and applied even over curved surfaces (Photo 9).

MAPELASTIC:
- is waterproof;
- bonds very strongly to the substrate;
- has extended open time;
- can be sprayed on, even when pumped over long distances;


PHOTO 7

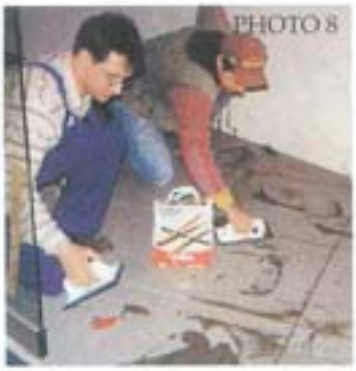


PHOTO 8


PHOTO 9


PHOTO 10

- can bridge cracks up to 1 mm wide;
- is fiber-reinforced.

ELASTOCOLOR* was used to paint the stations' vaulted ceilings. ELASTOCOLOR is a flexible protective and decorative acrylic resin-based water-dispersion paint.

When completely dry, ELASTOCOLOR forms a flexible waterproof covering that is resistant to atmospheric agents yet is permeable to water vapor. ELASTOCOLOR has excellent resistance to aging, frost, and deicing salts and makes surfaces very resistant to dirt.

For the beautiful finished installation, see Photo 10.

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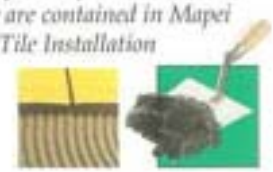
The technical data sheets for the products mentioned in this article are contained in Mapei binders No. 1 "Ceramic Tile Installation Products" and No.3, "Building Specialty Line"



TECHNICAL DATA

Project: Broich and Stadtmitte Metro stations in Mülheim/Ruhr, Germany.

Year built: 1997-1998

Project design and management: U-Bahnhof Tiefbau Ruhr, Germany

General Contractor: Heddenhausen GmbH Dienslaken

Materials: Granito Branco Perola, Rosa Forte and Bianco Cristal, AWS 5x24 cm glazed ceramic tiles, 11.5x24 and 24x24 cm Buchtal clinker.

Mapei products*
- **for the granite installations:**
PLANICRETE, GRANIRAPID, ULTRACOLOR
- **for the glazed ceramic tiles:**
PLANICRETE, NIVOPLAN, PRIMER G, ADESILEX P9, ULTRACOLOR
- **for the clinker:**
PLANICRETE, KERAFLEX, ULTRACOLOR
- **for the vaulted ceilings:**
MAPELASTIC, ELASTOCOLOR

*The products mentioned in this article are manufactured by Mapei in Europe.