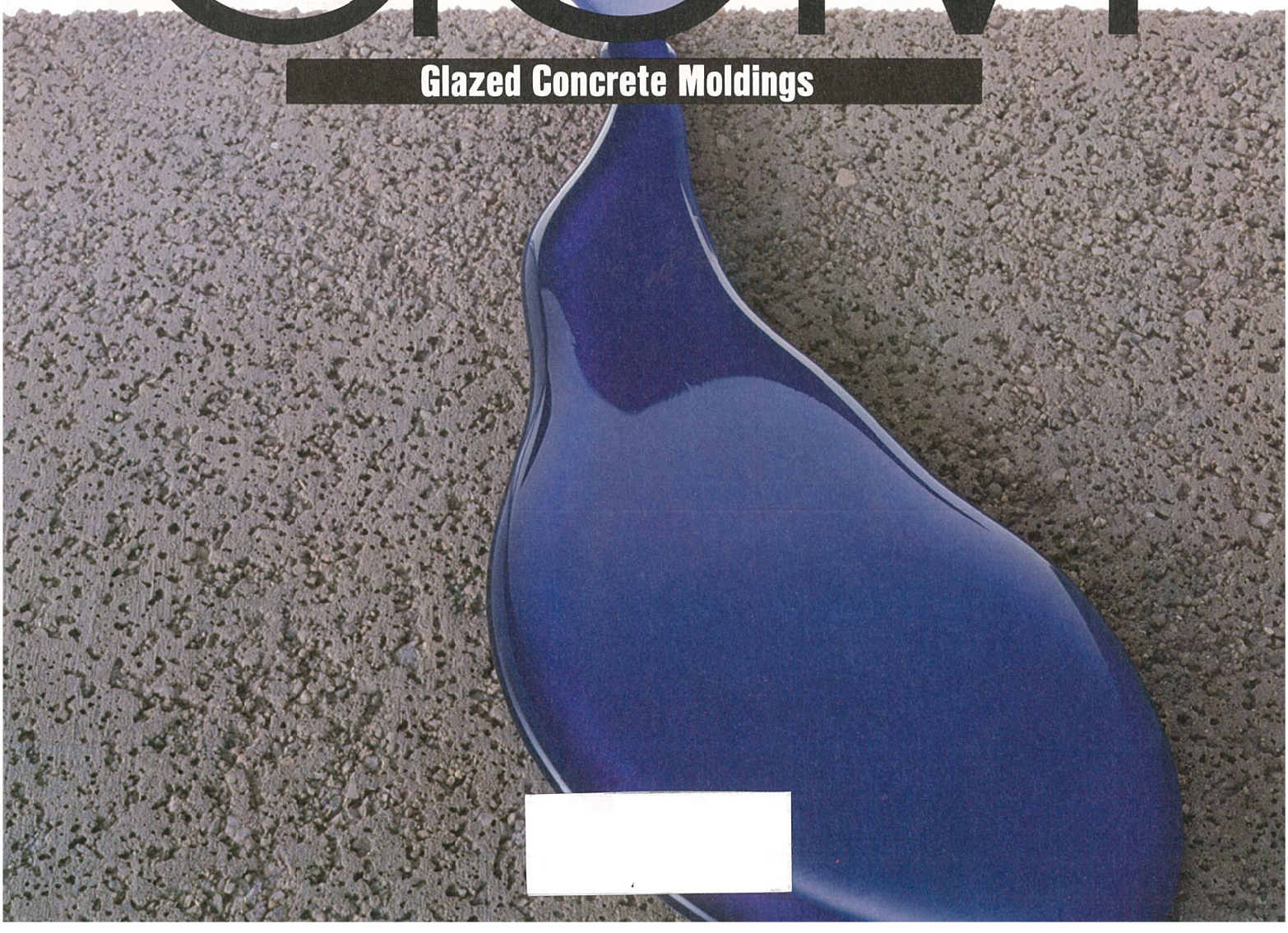
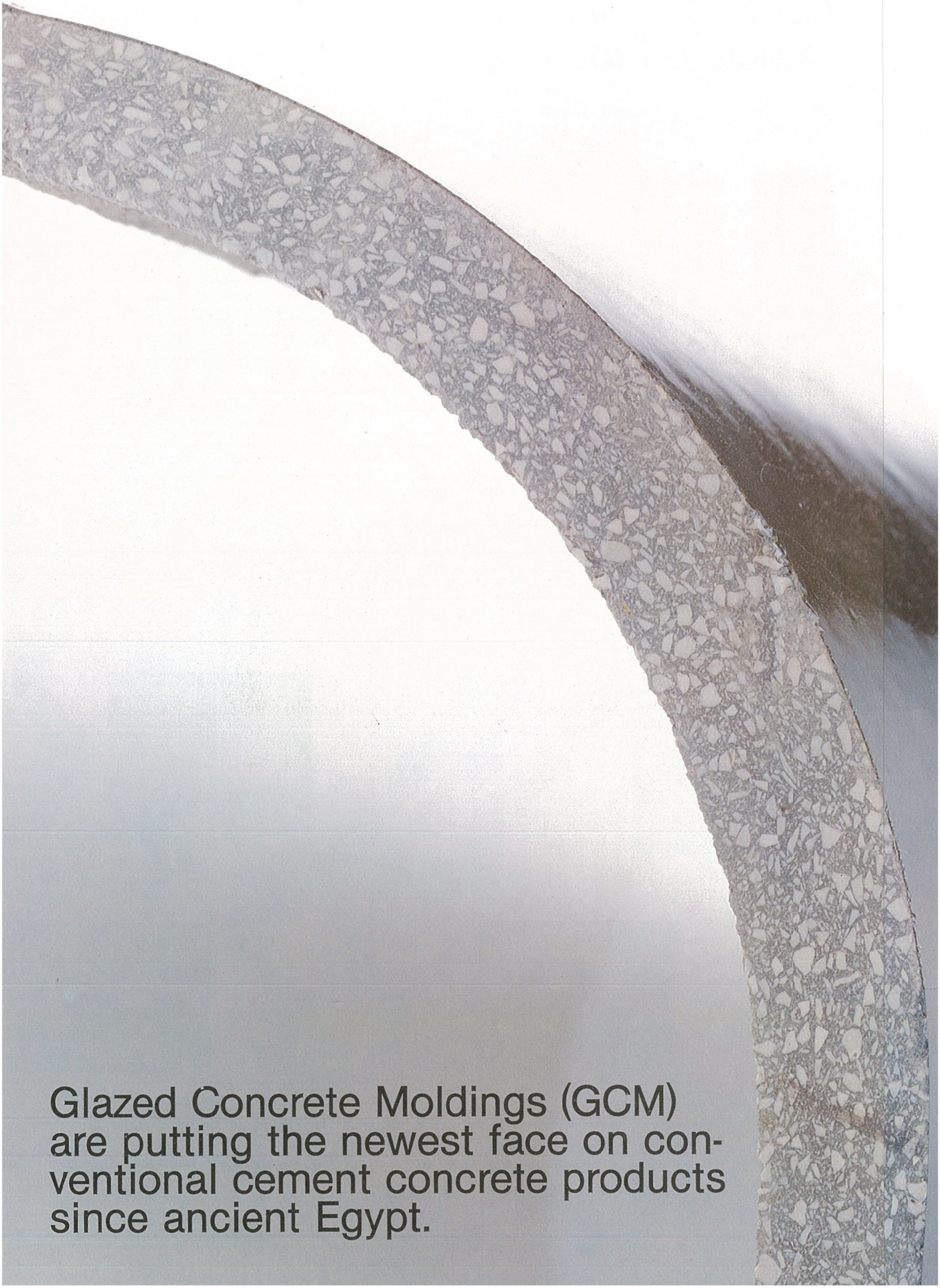
# GCM

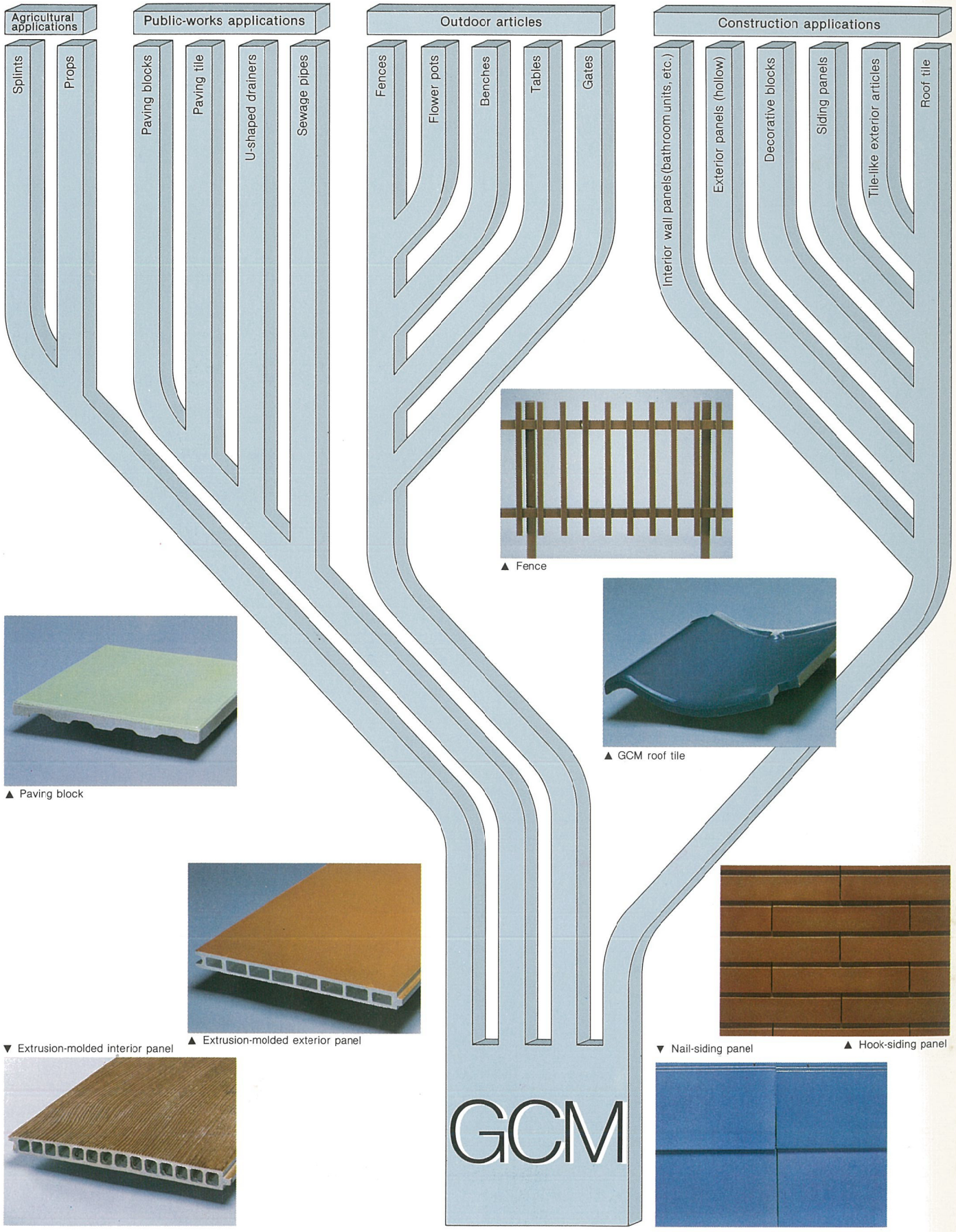
## Glazed Concrete Moldings





Glazed Concrete Moldings (GCM) are putting the newest face on conventional cement concrete products since ancient Egypt.

# GCM has given Ceramic Luster to Concrete Products.




▲ Fence

▲ Paving block

▲ GCM roof tile

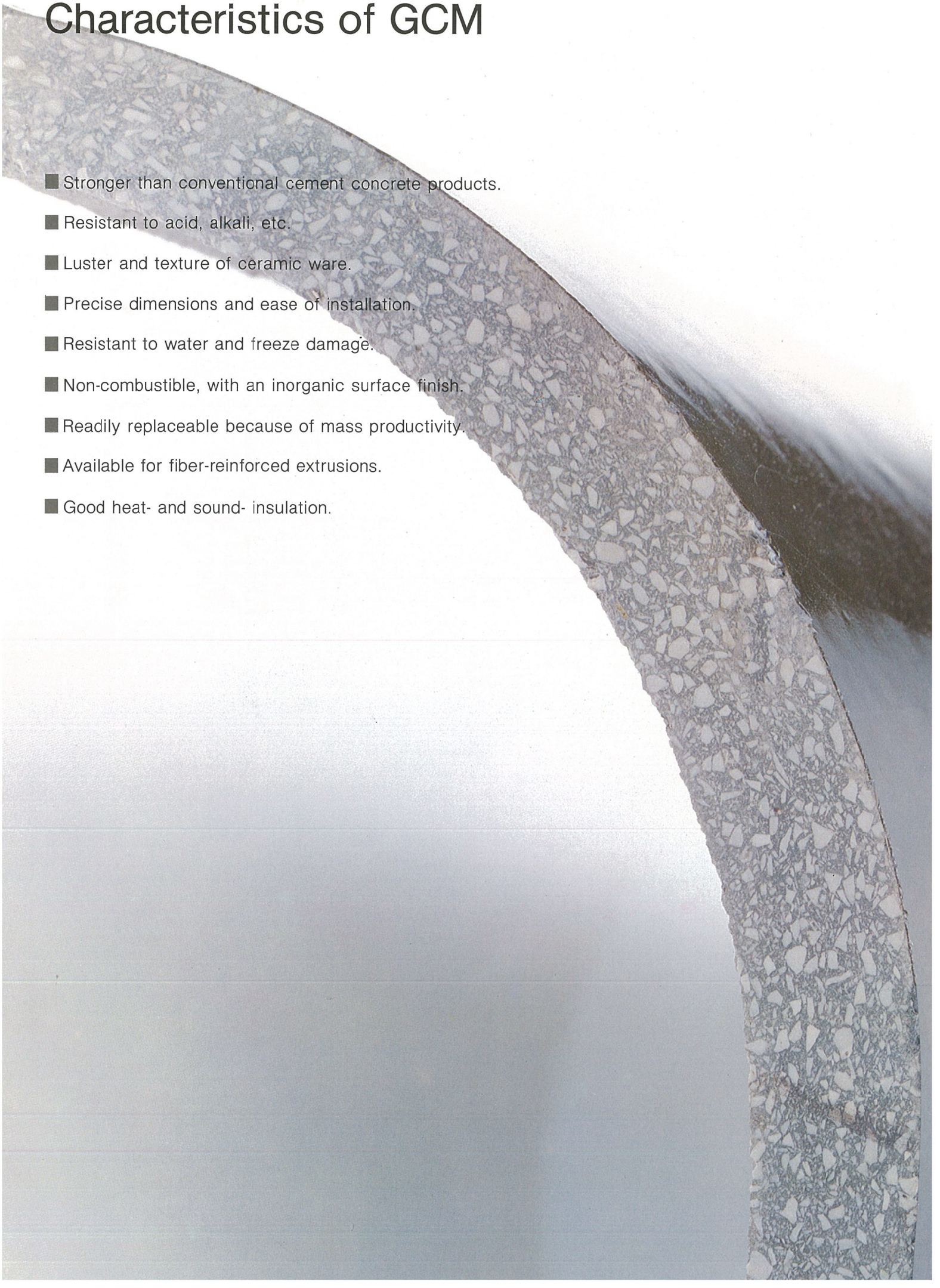
▲ Extrusion-molded exterior panel

▼ Extrusion-molded interior panel

▼ Nail-siding panel

▲ Hook-siding panel

# Characteristics of GCM



- Stronger than conventional cement concrete products.
- Resistant to acid, alkali, etc.
- Luster and texture of ceramic ware.
- Precise dimensions and ease of installation.
- Resistant to water and freeze damage.
- Non-combustible, with an inorganic surface finish.
- Readily replaceable because of mass productivity.
- Available for fiber-reinforced extrusions.
- Good heat- and sound- insulation.

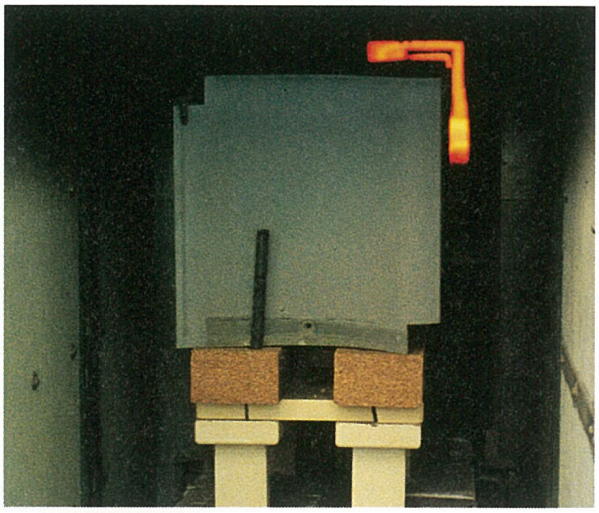
The GCM surface-finished attractively
and durably on concrete has been developed by
Ina Seito Company, while the GCM retains outstanding merits of
conventional cement concrete, such as non-combustibility,
durability, accurate dimensions, resistance to decay and corrosion, and good moldability.
Previously, it was believed that cement concrete could not be fired to glaze it,
because the strength of conventional concrete products
deteriorates and does not recover when fired at temperatures over 500°C.
Ina Seito Company conducted lengthy, intensive research into glazing cement
concrete without deteriorating its strength.
The company found in 1977 that specific cement concrete could be fired for glazing
at temperatures as high as 900°C,
and that its strength could be even increased by
final hydration after firing.
Further successive improvements have been made,
and the resulting GCM is now available
the world market.

# How to Produce the Epoch-making GCM ——— Glazed Concrete Moldings.

In order to glaze cement concrete, the concrete treated with a glaze agent should be fired at a high temperature to melt the glaze. Otherwise the concrete and glaze will not be unified into glazed concrete. Such high temperature treatment results in deterioration of durability, weathering and appearance. Also, conventional concrete can not withstand thermal expansion and contraction when fired at such high temperatures, leading to irrecoverable loss in strength. These opposite factors had to be satisfied at the same time to obtain glazed cement concrete products.

Ina Seito Company solved the problems by utilizing specific aggregate (reinforcing particles for concrete) and employing novel firing and hydrating conditions.

The raw materials are cement, specific aggregate and water. As necessary, reinforcing fibers, pigments and other additives can be added according to aimed properties. Cement means inorganic materials that harden through hydration reaction. Normal portland cement containing no furnace slag is generally preferred in view of strength and other properties. The aggregate to be used is a specific material that is free from rapid expansion and contraction when subjected to firing and cooling steps. On the contrary, if cement concrete containing conventional river sand as aggregate is fired over 500°C, quartz of the sand undergoes extraordinary expansion, and also free lime in the

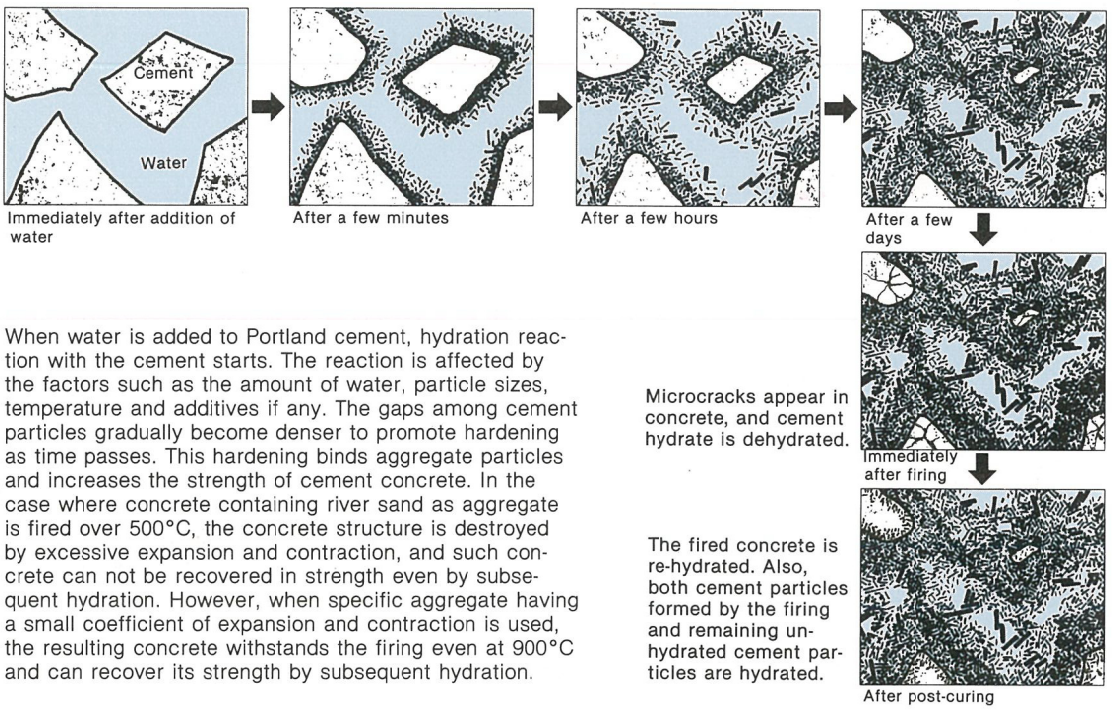


cement undergoes expansion and contraction by the reaction of $Ca(OH)_2 \rightleftharpoons CaO + H_2O$. Thus the concrete structure is loosened and often destroyed.

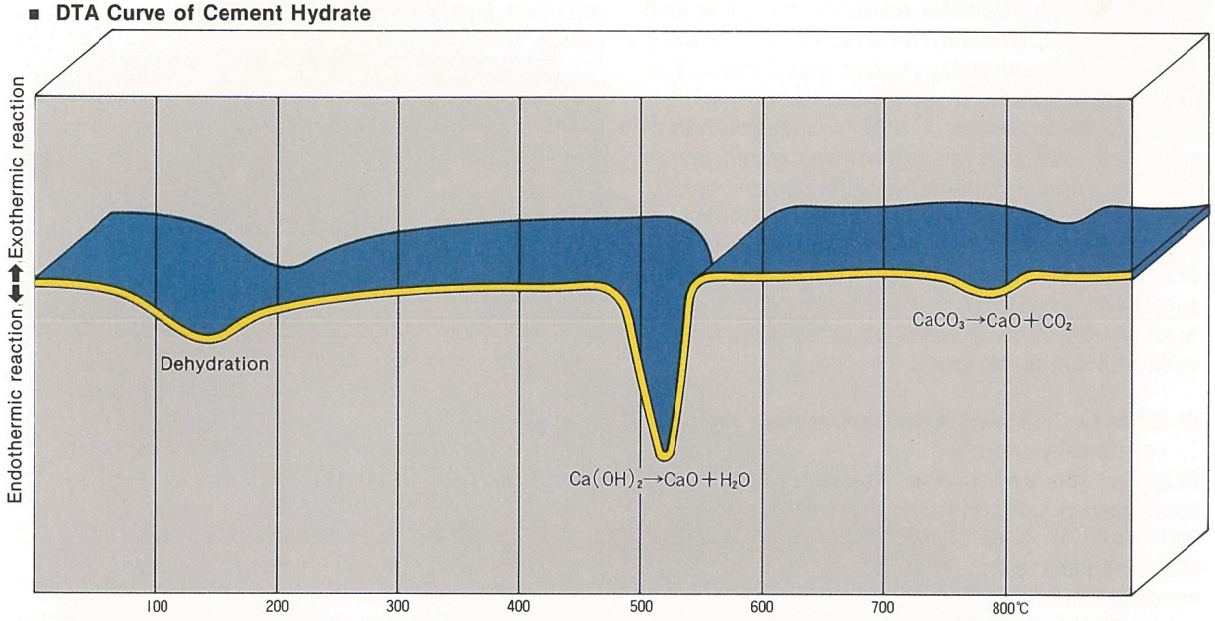
It was unexpectedly found that cement concrete, molded together with the specific aggregate and fired even at 900°C to glaze it, could recover and further increase its strength by hydration after the firing. The GCM (glazed concrete moldings) is based on such findings.

The process for producing the GCM comprises

■ **Illustration of the pre-curing, firing and post-curing procedures.**



■ **DTA Curve of Cement Hydrate**



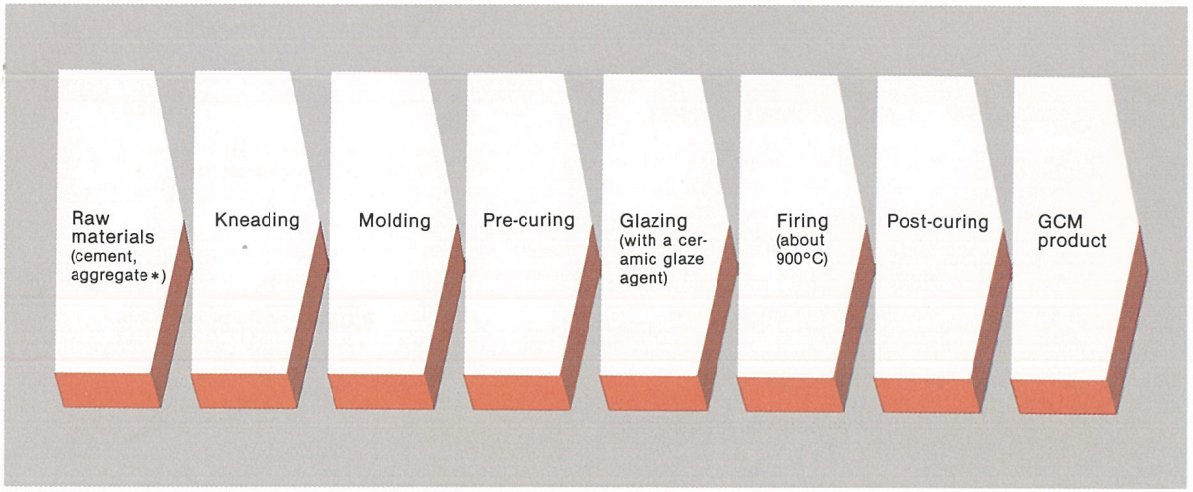

the steps of molding concrete article, curing, glazing, firing and hydrating the fired article, as shown in the following example of a GCM board.

Portland cement and specific aggregate are mixed in a ratio of 1:2 by weight, water is added, and the resulting mixture is kneaded sufficiently. A measured amount of the kneaded material is placed in a compression mold, and then subjected to compression-dehydration molding under about 80 kgf/cm$^2$. Incidentally, other molding methods such as centrifugal molding, screen molding, casting and extrusion molding are also employed, but high-pressure molding methods such as the compression molding are generally preferred.

The molded article is taken out on a receiving plate and pre-cured for one day. The precuring step is carried out in either air, water, steam or an autoclave. The precuring step, however, is terminated when some cement particles remain unhydrated. The molded article is treated with a glaze agent and fired for about 15 minutes at a temperature of up to 900°C. The suitable firing temperature and time can be selected according to the types of aggregate, a glaze agent and the like to be used. Following the firing step, the fired article is soaked in water to supply water which was driven away from the article by the firing. The article is then post-cured as in the precuring step.

You will note that the fascinating GCM is readily produced by addition of the glazing, firing and post-curing steps only to the process for molding conventional cement concrete.

■ **Illustration of the Process for Producing GCM.**




* Additives and reinforcing materials can be added as necessary.

# The GCM (Glazed Concrete Moldings) Realizes your Dreams.

Inventions of the GCM based on the intensive long research came out with 18 patent applications in Japan and several foreign patent applications. The fundamental inventions were patented or published. In the meantime, Ina Seito Company has subjected GCM roof tile to severe exposure tests for many years in comparison with conventional tiles at the cold, mild and hot regions in Japan, and proved the durability and reliability of the GCM products. Now, Ina Seito Company is prepared with confidence to license the patents and or know-how of the process for production of the GCM throughout the world.

- **GCM is improved in its properties over conventional concrete**

GCM provides even greater strength than conventional cement concrete. The GCM fired even at 900°C and hydrated is improved in strength, durability and weathering. Incidentally, the cement concrete containing river sand as aggregate can not be fired without deterioration of its properties.

- **GCM resists chemicals such as acid and alkali**

Filter paper impregnated with 10% hydrochloric acid was placed on samples for 24 hours. Conventional cement concrete suffered severe corrosion, but GCM had no adverse effects.

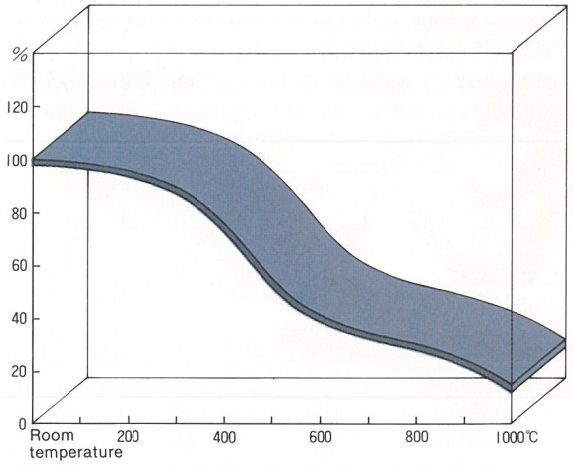
- **GCM has the luster and texture of ceramic ware.**

GCM has surface finish with the tint and luster comparable to those of ceramic ware. Such surface finish will be satisfied by all users.

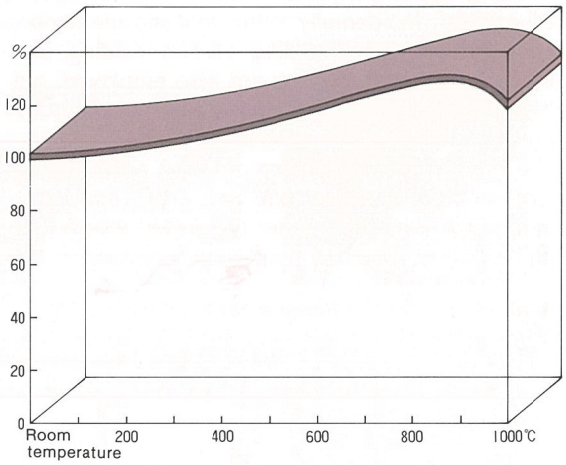
- **GCM articles are dimensionally accurate without substantial deformation, and have good installation properties.**

GCM has very small molding shrinkage and provides dimensionally accurate articles. In the case of conventional roof tile, professional skills were required for tiling because each tile was much or less different in dimensions. GCM tile is uniform in dimensions, and the efficiency of installation is markedly improved with neatly installed appear-

■ **Comparison of Bending Strength between GCM and Conventional Concrete**
(The value of 100% means the strength of a test piece which was not fired.)




* Normal cement concrete loses its strength markedly when fired above 400°C and hydrated.

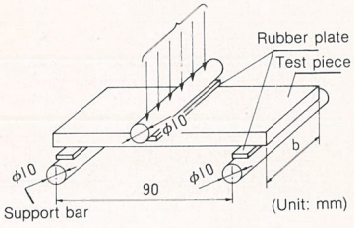



* GCM using specific aggregate is actually increased in strength when fired up to 900°C and then hydrated.

■ **Bending Strength Test** A test piece is placed on two supporting bars which are 10 mm in diameter and spaced 90 mm apart. Load is then applied to the test piece through a 10 mm diameter bar that was mounted in the center of the span. Between the test piece and the bars are placed rubber plates having thickness of about 3 mm and hardness of 60 to 70 according to an A-type spring hardness tester as defined in JIS K 6301 (a physical test method of vulcanized rubber). The loading velocity is adjusted to 6.5 mm/min. Bending fracture load per cross-sectional unit area is obtained from the following expression.

Bending fracture load per cross-sectional unit area ($kgf/cm^2$) $= \frac{3PL}{2bt^2}$

L: Span (9 cm)
P: Fracture load kgf
b: Width cm
t: Thickness cm

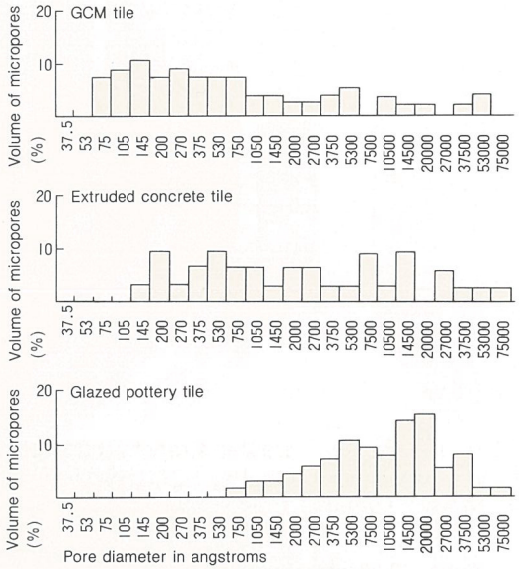


## ■ Comparison of Performances between GCM Roof Tile and Other Roof Tiles

*Test results at Ina Seito Company

| Items \ Types | GCM tile | Extruded concrete tile | Glazed pottery tile |
|---|---|---|---|
| Dimensions | 325×305mm | 420×330mm | 305×305mm |
| Maximum working dimensions | 272×251mm | 345×300mm | 235×265mm |
| Thickness | About 13mm | About 14mm | About 16mm |
| Pieces required per 3.3m² | 48 pieces | 32 pieces | 53 pieces |
| Weight | About 3kg | About 4.5kg | About 4kg |
| Tiling weight | 45kg/m² | 44kg/m² | 65kg/m² |
| Bending force | 175kgf | 198kgf | 175kgf |
| Bending strength | 132kgf/cm² | 120kgf/cm² | 86kgf/cm² |
| Water absorption rate | 7.8% | 6.3% | 7.6% |
| Amount of water penetration(24 hrs) | 1mm | 2mm | 75mm |
| Freeze-thaw test | Excellent | Bad | Good |
| Fire resistance | Excellent | Excellent | Excellent |
| Insulation to heat | Good | Good | Good |
| Insulation to sound | Good | Good | Good |
| Relative difficulty in repair | Good | Good | Good |
| Volume of micropores | 579.7×10⁻⁴cm²/g | 4544×10⁻⁴cm²/g | 1293×10⁻⁴cm²/g |

## ■ Distribution of Micropores




ance. The dimensional accuracy and mass productivity of GCM articles also enhance ease of repair and replacement. A variety of molding methods are employed to produce durable high-quality GCM products for many applications. For example, extrusion molding can be applied to long, large or fiber-reinforced GCM articles.

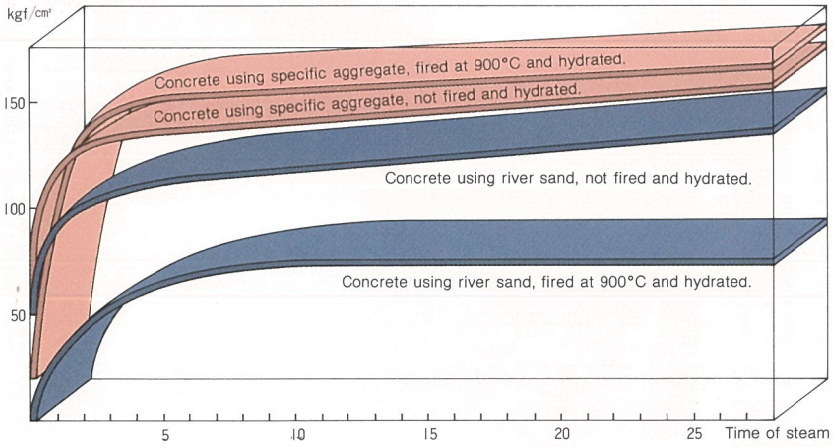
● **GCM is highly resistant to water.**

Water penetration of GCM in 24 hours is 1/75th of pottery articles. Thus, external water or moisture is substantially excluded from GCM, which minimizes freeze damage. GCM will be most suitable for roof tile and other exterior construction materials in cold climates.

● **GCM is completely non-combustible because of purely inorganic surface finish**

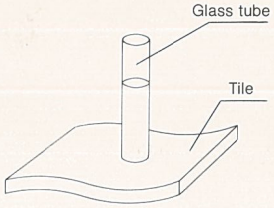
The resistance to heat and flame of cement concrete is influenced by aggregate used in a larger amount rather than cement used in a smaller amount. The specific aggregate of GCM has a much lower coefficient of expansion than the river sand used in conventional concrete. GCM is thus very resistant to the microcracks that occur in conventional concrete when exposed to flame. The glaze of GCM is also purely inorganic, which serves to enhance the resistance to heat and flame.

## ■ Bending Strength




* Comparison in the bending strength between the concrete using specific aggregate and concrete using river sand which were fired or not fired and hydrated.

■ **Water Penetration Test** Entire tile which has been allowed to stand at room temperature for one week is used in this test. A 35 mm diameter glass tube is placed upright in the center of this tile, water is put in the tube, and the water level is read as time passes to determine the amount of water thus penetrated.




■ **Freeze-Thaw Test** Entire tile is soaked in water for 24 hours or more, and then is placed in a freeze-thaw testing device. The tile is subjected to a cycle consisting of freezing at −20°C for 50 minutes and thawing with a 30°C water shower for 20 minutes. This cycle is repeated 1,000 times to observe the changes of the tile such as cracks, crazing and peeling.