

**Abstract:**

*A new environment-friendly block, called “ Ferroform,” consisting mainly of steelmaking slag (corresponds to aggregate), ground granulated blast furnace slag (corresponds to binder) was developed. Ferroform has the same strength and durability as concrete. It can be used a substitute for concrete blocks, natural stones and fresh concrete. In repair work at Mizushima Port, 150 000 t of stones.*

In Japan, the Basic Law for Establishing the Recycling-based Society was enacted in 2009(2)-14(09(2)-14(TJETBT/TT0 1 Tf10 0 0 10 53.8575 314.3654 Tm(t)-12(h)-12(e)-12(-)-5



strength values indicated in the table are those measured at a compressive strength of  $24 \text{ N/mm}^2$ , which is the common proportioning strength of blocks. Because the values of tensile strength, flexural strength and Young's modulus of Ferroform are on the same level as those of concrete, its design strength can be the same as with concrete.

In addition, as steelmaking slag, which has a higher density than natural aggregates (density in saturated surface-dry condition:  $2.8\text{--}3.6 \text{ g/cm}^3$  for steelmaking slag;  $2.7\text{--}2.8 \text{ g/cm}^3$  for natural aggregates), is used as a material for Ferroform, it has a greater mass per unit volume than concrete, being  $2.4$  to  $2.6 \text{ t/m}^3$  for the standard mixture as compared with  $2.3 \text{ t/m}^3$  for normal-weight concrete. This



Ferroform was used as an alternative to fresh concrete in the basement filling project in the area of JFE Steel's Chiba District, East Japan Works (2003). A total volume of 3 492 m<sup>3</sup> of Ferroform was mixed and shipped in 13 man-days (269 m<sup>3</sup>/day on average).

After mixing, fresh Ferroform was pumped up and fed under pressure to the site of placing at a delivery rate of 60 m<sup>3</sup>/h and horizontal conversion distance of 150 m and using a pipe having a diameter of 125 mm, as shown in . The set slump was 210 mm, which although high, did not cause separation and good pumpability was maintained.

Fluctuation in compressive strength of the fresh Ferroform used for this project, at age of 28 days, is shown in <sup>5)</sup>. When the proportioning strength is 15 N/mm<sup>2</sup>, the average compressive strength is 15.0 N/mm<sup>2</sup> with coefficient of variation of 5%. Since the common coefficient of variation is 10% or less in a well-controlled ready-mixed concrete factory<sup>6)</sup>, it is expected that the strength of Ferroform can be controlled to a level similar to that of concrete.

In addition to the use as substitutes for concrete blocks and natural stones in port construction works, Ferroform can also be used as an alternative to fresh concrete in basement filling projects as illustrated in this section.

roform, consisting mainly of steelmaking slag (aggregate) and ground granulated blast-furnace slag (binder), has strength and durability characteristics equivalent to those of concrete. In addition, leaching of alkali components from Ferroform is less than from concrete.

Ferroform has already been used as a substitute for concrete blocks and semi-hard natural stones in various port construction works. In addition, it can be used as an alternative to fresh concrete in basement filling projects.

The JFE Steel Group will continue to conduct research and development on new applications of steel-making slag to help create a recycling-oriented society.

- 1) Tekkou suragu toukei nenpou (Heisei 19 nenndo zisseki). Nippon Slag Association. 2008.
- 2) Kogiku, Fumio; Hamada, Hidenori; Yamazi, Toru; Matsunaga,

The newly developed steel slag hydrated matrix, Fer-