Gypsum

Introduction

Gypsum is a non-hydraulic binder occurring naturally as a soft crystalline rock or sand. Pure gypsum is a white in colure and is so soft that it can be scratched by a finger nail.

When heated to 205°C, pure gypsum loses its luster and its specific gravity is increased from 2.3 to 2.95 due to the loss of water of crystallization.

Gypsum has a unique property of moulding. When heated it gives up combined water and easily turns into powder. On adding water to the powder it can easily be shaped and moulded, and in a short time it hardens again and becomes similar to what it was in its natural state.

There are two commercial varieties of crude gypsum, rock gypsum and gypsum or gypsite , used for the manufacture of gypsum binding material. These substances consist principally of a hydrous sulphate of lime ($CaSO_4 + 2H_2O$) with varying percentages of silica, carbonate of
lime, carbonate of magnesia, and iron oxide.

Building gypsum is an air-setting binder composed mainly of semi hydrate gypsum and obtained by processing gypsum at temperatures 150°C–160°C.

Properties and shortcomings of Gypsum

Gypsum items have a number of valuable properties like :

1. small bulk density,
2. incombustibility,
3. good sound absorbing capacity,
4. good fire resistance, rapid drying and
5. hardening with negligible shrinkage,

6. superior surface finish,
7. resistance to insects and rodents
8. low energy input during burning to produce gypsum plaster.

The major shortcomings are :

1. its poor strength in wet state
2. high creep under load.

Effect of heat and moisture

The water of crystallization in the gypsum ($CaSO4 \cdot 2H2O$) is not held firmly by the mineral. Therefore, when it is heated to about 160°C it loses a part of water of crystallization and is known as ***half-hydrate gypsum***.

$$2CaSO4 \cdot 2H_2O \xrightarrow{160°C} 2CaSO4 \cdot \tfrac{1}{2}H_2O + 3H_2O$$

Gypsum Plaster of Paris

At still higher temperatures (About 200°C), gypsum loses all its water of crystallization and turns out into an hydrate gypsum.

$$CaSO4 \cdot 2H_2O \xrightarrow{200°C} CaSO4$$

The lost water of crystallization can be regained under moist conditions.

$$2CaSO \cdot \tfrac{1}{2}H_2O + 2H_2O \rightarrow 2CaSO \cdot 2H_2O$$

$$CaSO4 + 2H_2O \rightarrow CaSO4 \cdot 2H_2O$$

Gypsum products

Plaster of Paris

Plaster of Paris, quick-setting gypsum plaster consisting of a fine white powder (calcium sulfate hemihydrate), which hardens when moistened and allowed to dry .

Uses

Plaster of Paris does not generally shrink or crack when dry, making it an excellent medium for casting molds. It is commonly used to precast and hold parts of ornamental plasterwork placed on ceilings and cornices. It is also used in medicine to make plaster casts to immobilize broken bones while they heal, though some orthopedic casts are made of fiber glass or thermoplastics.

Manufacture of Plaster of Paris

Plaster of Paris is prepared by heating calcium sulfate dehydrate, or gypsum, to 120–180 °C (248–356 °F). With an additive to retard the set, it is called wall, or hard wall, plaster, which can provide passive fire protection for interior surfaces.

Chemical requirement in accordance with Iraqi standard No. 28 – 1985

1. (Na2O +MgO) not more than 0.25% by weight of plaster
2. The percentage of chemically combined water should be between 4-9%
3. The percentage of impurities not more than 5%

Physical requirement in accordance with Iraqi standard No. 28 – 1985

1. Fineness : the percentage retained on 1.18 mm sieve not more than 1%
2. Setting time : should not be less than 20 minutes
3. Compressive strength : not less than 5 N/ mm^2

Ordinary plaster

It is a hemihydrate product $CaSO4 . ½H_2 O$, produced by calcination of a gypsum containing certain natural impurities , or by the addition of a certain materials which serve to retard the set of pure gypsum

Uses

1. It is used as a wall plaster in first and second coat
2. It is used as a mortar masonry construction

Technical plaster

Technical plaster. Is calcined gypsum produced by heating gypsum in either vertical or horizontal furnaces at temperature between (120 to 170 ºC) and for a period of half to three hours.

Uses

1. It is used as a wall plaster in first and second coat
2. It is used as a mortar masonry construction

Anhydrous plaster

Is produced by the complete dehydration of gypsum at temperature exceeding 190c .It has low solubility of water compared with ordinary gypsum

Uses

1. As a wall plaster in all coats
2. It is used as a mortar masonry construction

Keene's cement

is made by burning a very pure rock gypsum at a red heat (700°C), cooling, and then adding 1.0 per cent of potassium and aluminum sulphates to accelerate the set. Subsequently the material is ground so that 90 per cent or more passes No. 100 sieve.

Properties

1. It is pure CaSO4 of pure white colour.
2. Keene's cement is not injured by storage and mortars of it may be re tempered.
3. Set occurs between 20 minutes to 6 hours.
4. At 7 days the tensile strength is 3.16 N/mm2.

Uses

It is used as a finish plaster only where a greater resistance to moisture and surface abrasion is required.

Gypsum plaster board

It is a gypsum product made of thin layers of card board or wood cemented together with wall plaster, used for lining walls and ceiling of buildings. The boards may be strengthened by incorporating fibers as fibrous gypsum plaster boards. They are very light weight and have high fire resisting properties. Gypsum plaster boards can be sawn to desired size and shape. They are available in widths 400, 600, 800, 900, 1200 mm; in length 1200, 1500, 1800, to 3600 mm in steps of 100 mm and; in
thickness 9.5 to 15 mm. They are classified as

1- Gypsum wall board

it has a face to which decoration may be applied.

2- Gypsum wall board with reduced water absorption rate These boards have additives in the core and/or /the paper liners to reduce water absorption