Published: December 15, 2002
Last Updated: June 4, 2013

GYPSUM

GYPSUM (Pers. Gač; CaSo4.1/2H2O), produced from natural gypsum rock (pure CaSO4.2H2O) by firing in kilns or piles and subsequent pulverization by pounding and grinding. The addition of water during the building process returns the material to its solid consistency. Various processing qualities can be achieved by different firing temperatures, normally between 120°C and 400°C, mostly below 200°C; only plaster for floors (CaSO4) needs 800°-1100°C. Unlike lime (See ĀHAK), which is tempered with high percentages of sand, gypsum is mainly used pure, not regarding natural impurities (e.g., lime and quartz). However, for economic reasons the addition of considerable portions of clay may be used in inferior structures, and a mixture of gypsum and lime is regarded as favorable for increasing its solidity and for the compensation of the delating and shrinking qualities of gypsum and lime respectively. Traditional craftsmen's recipes for improving the strength of gypsum by adding crushed minerals (*kavers*, *gargar tuz*), syrup (*šira*), potash, cut animal hair or botanic fibers, lime water, and other ingredients are reported (information obtained from local craftsmen in Fārs and Azarbaijan). The main shortcoming of gypsum as a construction material is its solubility by water, which excludes its use for hydro-construction and makes it unsuitable for wet founda-tions and for building in humid climate; there the more resistant lime prevails, the disadvantages of which are complicated production procedures and high-energy-consuming firing conditions of 800°-900°C for several days. Although the compression strength of gypsum is inferior to that of lime, it is sufficient for normal constructive requirements. Its main advantage over lime is a very short setting time, which can be manipulated and precisely calculated

according to requirements, and which not only allows a quick and continuous building process but also makes it suitable to a certain degree as an adhesive. The development of gypsum technology seems to have begun later than, but in close connection with, that of lime technology, due to the frequent blend of the two in the rocks of the quarries and the general similarity of the raw materials. The distinction between ancient gypsum and lime plaster as well as the restitution of the ancient processing methods are not always clear. Near Eastern Neolithic Cultures had achieved an extraordinarily high standard in processing plaster, mainly lime, for a wide range of purposes, as early as in the 8th millennium B.C.E (Aurenche, pp. 503 ff.; Kingery, pp. 219 ff.; Rehhoff, pp. 79 ff.). In architecture, plaster was mainly used for coating walls and floors, e.g., for polished lime or gypsum floors in the pre-pottery Neolithic B settlement of ʿAin Ghazal in Jordan (Rollefson, pp. 36 ff.), in Jericho (Kenyon, 1957, pp. 55 ff.; idem, 1981, pp. 289 ff.), or for the high-quality terrazzo floors of partly colored lime in Nevali Çori (Hauptmann, pp. 45 ff.) and Çayönü in Turkey (Çambel and Braidwood, pp. 161 f.). In 4th millennium Uruk, artificial building stones of gypsum appear beside lime mortar masonry (J. Schmidt, pp. 18-20), and walls and floors were plastered with gypsum here (Lenzen, pp. 21 ff.) as well as in the early 2nd millennium palace of Mari (Parrot, pp. 20 ff., 45 ff., 104 ff.). In 3rd millennium Egypt, lime, gypsum, and a mixture of both were used, e.g., in the pyramid of Chefren (Neuburger, pp. 406 ff.). In the Central Asian Bronze Age site of Togolok and Gonur in Margiana (Marv), Turkmenistan (Sarianidi, 1990, p. 161; 1993, fig. 20.35, 36, 40; Hiebert, pp. 15 ff., 121, 126, 198), and Jarkutan in Uzbekistan (Askarov, pl. 53 f.) gypsum plaster on walls, floors, and floor installations were excavated. In the Achaemenid palaces at Persepolis, floors, walls, and wooden columns were coated with colored and painted gypsum (E. F. Schmidt, pp. 31 ff. 55, 159 ff. 222, 285 ff.; Tajwidi, pp. 177 ff.). A fundamental change and an enormous expansion of the use of gypsum in the Oriental, especially the Iranian, world began with the development here of vaulted stone and brick architecture during the Parthian period. With its vulnerability to water negligible in the arid Oriental countries, the technical and economical advantages of gypsum were fully exploited and it became the prevalent binding agent of masonry constructions up to present. The fast-setting quality of gypsum made possible the adoption for stone and fired-brick architecture of the age old system of mud brick vaulting with pitched courses, thus bringing about the replacement of columnar halls by monumental vaults. Vaulting with pitched courses starts from a back wall or any other supporting element and practically glues half rings of bricks or flat stones one in front of the other, each stone stuck into the pasty gypsum mortar

where it is fixed within a moment (Reuther, pp. 422 ff., 498 ff.). The method avoids centering, thus adding the saving of centering wood to the energy saving, low temperature firing of gypsum production. Since Sasanian time gypsum was used for producing prefabricated construction elements, armed with reeds or sticks, e.g., beams and lintels, and later on curved struts as assisting elements for arches, domes, and vaulting with pitched courses (Huff, pp. 155 ff.). Being a perfect background for painted decoration since its first appearance as wall plaster, gypsum was widely used for architectural stucco relief since Parthian time (Kröger).

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