

PUZZOLANAS AND PUZZOLANIC CEMENTS*

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Due to the present shortage of Portland cement in the country for our various multipurpose schemes of construction and the difficulties in importing the heavy machinery required for cement factories, it is of imperative need for our scientists to develop other types of special cements which are already in use in other countries of the world. The various cements used in the major constructional works are Puzzolanic cements, Sand cements, Modified cements and Blended cements. All these cements consist essentially of Portland cement and some additive which does not impair the properties of the former and hence lesser consumption of the Portland cement is effected. Amongst these the puzzolanic cements are very popular and have been found very useful not only for ordinary purposes, but also for massive works. Before going into the details of the puzzolanic cements, it is essential that we must know the meaning of puzzolana.

Puzzolana

Puzzolana is the name given to a loosely coherent volcanic sand found at Pozzuoli near Naples. This sand when mixed with lime was found to give good hydraulic cements. A substance is said to be puzzolanic when, while not necessarily cementitious by itself, it possesses constituents which will combine with hydrated lime or any other cementitious product at ordinary temperatures in the presence of moisture to form stable insoluble compounds of cementitious value.

Types of Puzzolanas

The above definition embraces a large variety of substances but the most important characteristic of a puzzolana should be that it should be economical and available in abundance (either as natural deposits or as factory by-product). For the practical purposes we can divide puzzolanas into:—

A:—Natural puzzolanas like Italian puzzolanas, Volcanic ashes, Diatomaceous earth, etc.

B:—Artificial puzzolana like Granulated Blast furnace slag, powdered bricks, *i.e.*, surkhi, etc.

Testing of Puzzolanas for Puzzolanic Activity

To select a puzzolana the Bureau of Reclamation² in Denver has developed four tests for puzzolanic activity.

a) **Flocculence Test**:—Here the powdered puzzolana is placed with saturated lime water in a sealed test tube and the height of the settled material is noted after various intervals of time and percentage increase in the height of the settled material in terms of the height of the liquid at the beginning of the test gives the activity.

b) **Lime Absorption Test**:—From the first test where a puzzolana is treated with saturated lime water in a sealed tube there is no more absorption of the

lime water, the quantity absorbed by puzzolana is also found out for estimating puzzolanic activity.

c) **Time of Setting**:—Here four parts of puzzolana and 1 part hydrated lime

Test	Puzzolanas	Puzzolanic Cements
% Si O ₂	Not less than 50%	Prepared by intergrinding 3 parts by weight of Portland cement clinker and 1 part of calcined Puzzolana.
% Ca O	Not greater than 10%	
Compressive Strength.	Lime sand mortar not less than 500 lbs. per square inch at 7 days curing and 800 lbs. per square inch at 28 days curing.	The same as of Portland cement.
Specific surface area.	—	Should not be less than 1,800 sq. cm. per gm.
Particle size	—	Not more than 12% should be retained when wet sieved on 325 mesh screen.

Note.—Other specifications for Puzzolanic Cements are the same as for Portland Cements.

are brought to normal consistency (according to A.S.T.M. methods) and initial and final setting times are noted.

d) **Compressive Strength**:—Cubes of 35 per cent Puzzolana and 65 per cent Normal Portland Cement with a water cement ratio 0.60 by weight are cured under specified conditions and the compressive strengths are compared with cubes made out of neat Portland cement.

Some of these tests have been tried and found quite useful for the selection of puzzolanas and more work to ascertain the suitability of these tests for Indian puzzolanas is in progress in the Unit.

But in all these tests the activity of the puzzolanas can be increased by pulverization and heat treatment. The average optimum temperature at which activity increases is near about 1450°F.

Puzzolanic Cements

After testing the puzzolana, the best ratio in which it should be mixed with cement, has to be found out. As a result of various tests performed at the Bureau of Reclamation in Denver, U.S.A., it has been found that 20-30 per cent is the optimum ratio and Portland puzzolana cements containing high lime clinker give better results than those containing medium or low lime clinker. The following are some of the other important conclusions:—

i) With excellent puzzolanas although the early strength may be less but later on the values are equal to that of straight cement.

ii) These cements show better tensile strengths and there is no fall in values till one year.

iii) These have lower heats of hydration and hence no great volume changes as in the other case.

iv) These cements offer greater resistance to alkaline waters and freezing and thawing effects.

v) These have a greater plastic flow and show relatively greater strength developments in lean concrete mixes than the rich ones.

From all these we can note the advantages that Puzzolanic Cements have over the ordinary Portland Cement and hence the need of developing such cement in this country.

Specifications

The following specifications³ have been laid down for Puzzolanas and Puzzolanic cements:—

Scope of Puzzolanic Cements

Apart from the ordinary uses to which such cements can be successfully put to, it is very remarkable that such cements were used for Bonneville Dam and other dams and no disadvantage has been reported till now. Here in our country too it is possible to develop these puzzolanic cements.

Surkhi^{4,5} is a very well-known puzzolana and is being used with limes for constructional purposes. The entire canal system in the Indo-Gangetic Plain has been built in the 19th century by using Puzzolanic material (Surkhi and powdered lime) when cement was not known. It is quite interesting to find if some clays on burning give rise to puzzolanas to be mixed with cements to manufacture puzzolanic cements. Some of the important types of clays can be tried.

Siliceous materials like shale, sandstone on burning can also give some good puzzolanas and hence can be used for the manufacture of puzzolanic cements. Coal ashes and boiler ashes may prove to be good puzzolanas and Blast furnace slag may also prove an excellent puzzolanas for our cement industry.

The work on these lines is already in progress at the Building Research Unit. However, as we have to develop our building industry rapidly it will be helpful if similar work could be undertaken on regional basis making the best use of any new locally available puzzolanic materials. It will thus give help to the industry and also help our cement manufacturers to meet the ever increasing demand of cement.

References:

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- 2 Bureau of Reclamation, Denver, United States Department of Interior.
- 3 "Specifications for Portland—Puzzolana Cement for Bonneville Dam," May 1935.
- 4 "Burnt Clay or Surkhi as Puzzolana" by Khan and Verma, Bulletin No. 21, Indian Industrial Research, Government of India.
- 5 "Water Content of Lime Puzzolana Mortar" by L. C. Jain, Journal of Scientific & Industrial Research, April 1949—Vol. VIII, No. 4.

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