

EXPERIMENTAL INVESTIGATION FOR THE KOTA STONE POWDER AS REPLACEMENT OF MARBLE POWDER IN MARBLE BRICK

JITESH MEHTA¹, DR. JAYESHKUMAR PITRODA²

¹Final Year Student, ME C.E. &M., BVM Engineering College, Vallabh Vidyanagar, Gujarat, India

²Assistant professor, Civil Engineering Dept., BVM Engineering College, Vallabh Vidyanagar, Gujarat, India

Abstract—The most basic building material for construction of houses is the conventional brick. The rapid growth in today's construction industry has obliged the civil engineers in searching for more efficient and durable alternatives far beyond the limitations of the conventional brick production. By incorporating Kota stone powder in Marble brick, compressive strength can be improved. Reduces the construction cost, maintenance cost. Also reduce the temperature up to 4⁰ C. Since marble and Kota stone consist of silica and lime, the strength of Kota stone powder brick is relatively more as compare to marble powder brick. The Marble powder has been replaced by Kota stone powder accordingly in the range of 20%, 40%, 60% and 80% by weight. The waste generated from the industries cause environmental problems. Hence the reuse of this waste material can be emphasized. To produce low cost brick, to reduce disposal and pollution problems due to the use of waste.

Keywords— Marble Powder, Kota Stone Powder, Granite Powder, Brick

I. INTRODUCTION

Rajasthan is the major centre of the marble, Kota stone industry in the country. More than 1,500 marble mines are operating in the Aravallis in Rajasthan, Rajasthan boasts almost two-thirds of India's mineable marble reserves, and it is responsible for around 85% of the country's total marble production. Indeed, the entire stretch of the Aravallis in lower Rajasthan is a vast depository of marble. Rajasamand, Ramganj Mandi, Jhalawar, Udaipur, Kota and Banswara districts contribute over half the state's marble output. The marble reserves in India are estimated at 1,200 million tons, with Rajasthan accounting for 91% of the reserves. (19)

Marble slurry is a processing and polishing waste of mining industry. Its huge quantity is dumped on any empty land, agricultural fields, pasture lands, river beds and roadsides. The present dumping practices have been creating a number of nuisances and problems, including environmental and human health. Scientific disposal systems but with more emphasis on engineering utilization have to be developed simultaneously and as fast as possible. Construction industries can be the main user of marble slurry whether in bulk or minor quantities. The utilization of marble slurry in the manufacturing of bricks, includes full replacement of conventional fine aggregates with marble slurry content. (9)

II. EXPERIMENTAL MATERIAL

(a) Marble Powder

Marble is a non-foliated metamorphic rock composed of recrystallized carbonate minerals, most commonly calcite or dolomite. Geologists use the term "marble" to refer to metamorphosed limestone. The marble powder generated during the cutting and Polishing Process of Marble is called Stone Waste. Marble stone industry generates both solid waste and stone slurry. During the process of cutting, in that original stone waste mass is lost by 25-30% in the form of dust. (15)

(b) Kota Stone Powder

Kota stone as is better known in building stone terminology, is basically a calcareous sedimentary rock available in a number of colours (blue, green, brown, Gary etc.) and textures. The stone deposits are well stratified and split easily all along the well-formed weak plans, facilitating smooth and well textured homogenous stone panels in various thickness. (19)

Kota Stone is a fine-grained variety of limestone quarried at Kota district, Rajasthan district Rajasthan India. Many hundreds of mines are located in or near the town of RamganjMandi and Kota district. The Kota stone sludge generated during the cutting and Polishing Process of Marble is called Stone. It is available in Ramganjmandi area of Kota and Jhalawar district. The important deposits of Kota stone are in Kota, Jhalawar, Chittorgarh and Jaisalmer districts, Rajasthan. Kota, Jhalawar, and Chittorgarh are the major producing districts of the dimensional Kota stone in the state. The Kota stone sludge generated during the cutting and Polishing Process of Kota stone is called Stone Kota stone sludge. Kota stone industry generates both solid waste and stone slurry. During the process of cutting, in that original stone waste mass is lost by 25-30% in the form of dust. (19)

(c) Cement (OPC)

The most common cement used is an ordinary Portland cement. The Ordinary Portland Cement of 53 grades conforming to IS: 8112- 1989 is being used. Table 1 shows the physical property of OPC cement of 53 grade.

Table 1: Properties of OPC 53 Grade Cement

Sr. No.	Physical Properties of Cement	Result	Requirements as per IS:8112-1989
1	Specific gravity	3.15	3.10-3.15
2	Standard consistency (%)	31%	30-35
3	Initial setting time (hours, min)	35 min	30 minimum
4	Final setting time (hours, min)	178 min	600 maximum

(d) Water

Water is an important ingredient of brick as it actually used for manufacturing of brick. Since it helps to bind all the raw materials for giving proper mix. Water used for making brick should be free from impurities.

III. PROPERTIES OF MARBLE POWDER AND KOTA STONE POWDER

The properties of marble powder and Kota stone powder was tested for their properties according to the relevant IS code provisions. Table 2 shows the physical properties of marble powder and Kota stone powder. Table 3 shows the chemical properties of marble powder and Kota stone powder.

Table 2: Physical Properties of Marble Powder and Kota Stone Powder

Property	Marble Powder	Kota Stone Powder
Bulk density (kg/m ³)	1300-1500	1568-1743

Fineness modulus (cm ² /g)	5100-5250	3900-4123
Water absorption (%)	22-24	2-4
Specific gravity	2.12-2.67	2.58-2.65
Max particle size (mm)	0.062	0.2
Colour	White/ Dirty white	Grey/ Dirty white

Table 3: Chemical Property of Marble, Kota Stone

Sr. No	Chemical Constituent	Chemical Composition (%)	
		Marble	Kota Stone
1	Calcium Oxide	40.41 %	38.86 %
2	Silica	18.57 %	26.67 %
3	Aluminum Oxide	2.09 %	2.20 %
4	Magnesium Oxide	0.43 %	1.09 %

(Source: Geo Test House, Vadodara, Gujarat, India)

IV. MANUFACTURING PROCESS

Collect the marble powder, Kota stone powder on site. Then the material is cleaned of impurities such as vegetation matter, stones or pebbles etc. After removing impurities it is exposed to weather for few days for drying the material and soaking the water from the material. After completion of weathering process the marble powder is blended with other fixed percent material to prepare the brick. Then mix the material in fixed percentage quantity by weight. After that, mix the material and pour the water as required in the mixture. Figure 1 show the manufacturing process of brick.



Figure 1: Manufacturing Process of Brick

V. BRICK MIXES

The brick mixes proportion's as shown in Table 4.

Table 4: Details of Brick Mixes with Marble Brick

Brick Mixes	Marble Powder (%)	Kota stone Powder (%)	Cement (%)	Total (%)
Marble Brick	80	-	20	100
B1	60	20	20	100
B2	40	40	20	100
B3	20	60	20	100
B4	0	80	20	100

VI. TESTS ON BRICKS [IS 3495 (Parts 1 to 4): 1992]

All the tests are performed at Govt. Engineering College Banswara, Rajasthan, which is a government engineering institute, equipped with standardized and sophisticated instruments and testing machines

Compressive Strength Test [IS 3495 (Parts 1 To 4): 1992]

230 mm × 110 mm × 76 mm standard size of a brick, The bricks, when tested in accordance with the procedure laid down in IS 3495 (Part I): 1992 shall have a minimum average compressive strength for various classes. Figure 2 shows the setup of compressive strength test. Table 5 shows the compressive strength of various mixes of bricks. (34)



Figure 2: Setup of Compression Strength Test

Table 5: Compressive Strength of Bricks (230x110x76) at 7, 14, 21days

Brick Mixes	Average Compressive Strength (N/mm ²)		
	7 DAYS	14 DAYS	21 DAYS
Marble Powder Brick			
Marble Brick	3.29	4.07	4.74
Kota Stone Powder Mixes Brick			
B1	3.05	3.72	4.83
B2	3.38	4.61	5.71
B3	2.93	3.82	4.31
B4	2.46	3.50	3.91

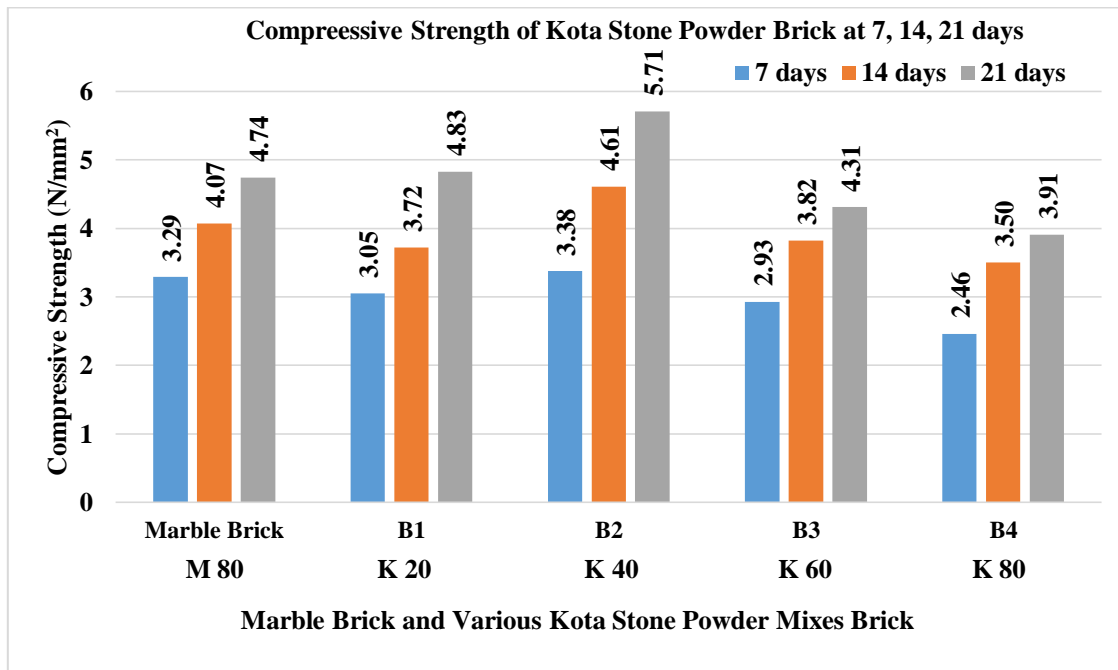


Figure 3: Compressive Strength of Marble Brick and Bricks by Inclusion of Different Proportion of Kota stone Powder in Marble Brick at 7, 14, 21 Days

From the above figure 3, it can be concluded that with replacement of Kota stone in marble brick the compressive strength increases gradually after replacement 20% and 40% Kota stone powder respectively after 21 days. But after increasing the quantity of Kota stone powder to 60% and 80% the compressive strength was found to be decreasing.

Water Absorption Test [IS 3495 (Parts 1 To 4): 1992]

Standard size Immerse completely dried specimen in clean water at a temperature of 27 f 2°C for 24 hours. Remove the specimen and wipe out any traces of water with a damp cloth and weigh the specimen. Complete the weighing 3 minutes after the specimen has been removed from the water.

The bricks, when tested in accordance with the procedure after immersion in cold water for 24 hours, water absorption shall not be more than 20 percent by weight up to class 12'5 and 15 percent by weight for higher classes. Figure 4 shows the water absorption of various mixes of bricks. (34)

Water absorption, percent by mass, after 24-hour immersion in cold water is given by the following formula:

$$(M_2 - M_1) / M_1 * 100$$

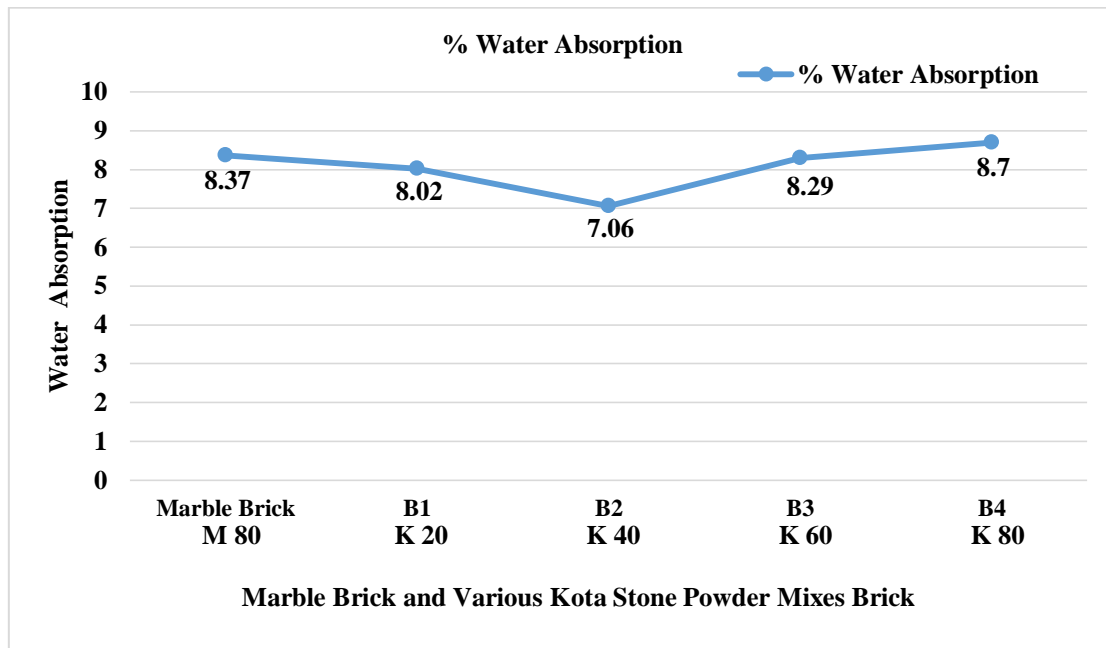


Figure 4: Percentage Water Absorption of Marble Brick and bricks by Inclusion of Kota Stone Powder in Marble Brick in Different Proportions.

From the above figure 4, it can be concluded that with replacement of Kota stone powder in marble brick the percentage Water absorption gradually decreases after replacement of 20% and 40% Kota stone powder, But after increasing the quantity of Kota stone to 60% and 80% the percentage water absorption is increases.

VII. CONCLUSION

Based on the experimental test results obtained from the study, the following conclusion are drawn

- The replacement of Kota stone powder in marble brick the compressive strength increases gradually after replacement of 20% and 40% Kota stone powder respectively after 21 days strength 1.90% and 20.46%.
- Replacement of Kota stone powder in marble brick the percentage of Water absorption gradually decreases.
- The possibility to use the Kota Stone Powder and marble Powder wastes as an alternative raw material in the production of brick.
- They are low cost, easy and speed of fabrication and recommend to be used in construction.

REFERENCES

- [1] Alaa A. Shakir, Ali Ahmed Mohammed., “Manufacturing of Bricks in the Past, in the Present and in the Future: A state of the Art Review”, International Journal of Advances in Applied Sciences (IJAAS), ISSN: 2252-8814, Volume 2, NO 2, , September 2013, pp. 145-156
- [2] Ankit Nileshchandra Patel., Prof. Jayeshkumar Pitroda., “stone waste as a ground breaking conception for the low cost concrete”, International Journal of Engineering Trends and Technology (IJETT), ISSN: 2231-5381, Volume 4, Issue 4, April 2013, 843-849
- [3] Ayesha Rehman., Abida Farooqi., Jahangir Mirza., “Utilization of Marble Dust and Steel Slag from Industrial Waste to Produce Non-Fired Environment Friendly Construction Bricks”, World Applied Sciences Journal, ISSN 1818-4952, Volume 2, Issue 32., 2014, 278-288
- [4] Dr. A.K. Soni, “Quarrying And Processing Waste For Development Of Value Added Products” Scientist-in-Charge & Head Central Institute of Mining & Fuel Research (CIMFR)
- [5] Dr.R.C.Gupta, “Effective Utilizations of Marble Dust for Industrial Applications,”

- [6] Feasibility Study for Setting Standards in Natural Stone Sector in Rajasthan,” Centre for Education and Communication (CEC) , New Delhi,
- [7] H N Rajendra Prasad, H G Vivek Prasad, Chetana Hamsagar, D Yogesh Gowda, Nikitha Marina Lobo, Sree Pushpak Gowda US, An Approach For Alternative Solution In Brick Manufacturing”, International Journal of Science, Environment and technology, ISSN 2278-3687 (O), Volume 3, Number 3, 2014, 1105 – 1114
- [8] Indian minerals yearbook 2013 part III, Marble,.,
- [9] Indian minerals yearbook 2013 part III, Granite,
- [10] J. S. Kamyotra Director, “Central Pollution Control Board” brick kilns in India.
- [11] José Manuel Cuevas Castell –AIDICO, “Application and reuse of slurries from natural Application and reuse of slurries from natural stone manufacturing” Carrera 23/05/2014
- [12] Kamel K. Alzboon., Khalid N.Mahasneh., “Effect of Using Stone Cutting Waste on the Compression Strength and Slump Characteristics of Concrete”, International Scholarly and Scientific Research & Innovation, Volume 3, No 3, 2009, 460-465
- [13] Kushwah RPSingh (Er: RPSingh kushwah)., “Engineering Utilization of Marble Slurry as Curing Aid.”, IJISSET - International Journal of Innovative Science, Engineering & Technology, ISSN: 2348 – 7968, Volume 1, Issue 5, July 2015, 437-444
- [14] M.S. Shetty “Contrete Technology”, 3rd Edition, S. Chand & Company Limited, Delhi, 1992
- [15] Mamta B. Rajgor., Jayeshkumar Pitroda., “A Study of Utilization Aspect of Stone Waste in Indian Context”, Gra - Global Research Analysis, ISSN: 2277 - 8160, Volume 2, Issue 1, January 2013, 50-53
- [16] Mamta Rajgor., Jayeshkumar Pitroda., “Stone Sludge: Economical Solution for Manufacturing of Bricks International Journal of Innovative Technology and Exploring Engineering (IJITEE), ISSN: 2278-3075, Volume 2, Issue 5, April 2013, 16-20
- [17] Masroor Ahmed Korai (Product Officer), “A Report on Marble & Granite”
- [18] Osman Sivrikaya, Koray R. Kiyıldı, “Zeki Karaca Recycling waste from natural stone processing plants to stabilise clayey soil” :Environ Earth Sci (2014) 71:4397–4407” DOI 10.1007/s12665-013-2833-x
- [19] Rajasthan Mineral Policy 2011,
- [20] Rajni Lakhani., Rajesh Kumar., Priyanka Tomar., “Utilization of Stone Waste in the Development of Value Added Products: A State of the Art Review ”, IJISSET - International Journal of Innovative Science, Engineering & Technology, ISSN 2348 – 7968, Volume 1, Issue 7, September 2014, 16-27
- [21] S. Dhanapandian., B. Gnanavel., “Using Granite and Marble Sawing Power Wastes in the Production of Bricks: Spectroscopic and Mechanical Analysis”, Research Journal of Applied Sciences, Engineering and Technology., ISSN: 2040-7467, Volume 2, Issue 1, 2010, 73-86
- [22] S. Dhanapandian., B. Gnanavel., An Investigation On The Effect Of Incorporation Of Granite And Marble Wastes In The Production Of Bricks”, ARPN Journal of Engineering and Applied Sciences, ISSN 1819-6608, Volume 4, Number 9, NOVEMBER 2009, 46-53
- [23] S. Dhanapandiana., M. Shanthib., Utilization Of Marble And Granite Wastes In Brick Products”, Jr. of Industrial Pollution Control, Volume 25, Issue 2, 2009, pp 145-150
- [24] Sarbapriya Ray, “An Analysis of Production Pattern of Brick Manufacturing Firms in India: A Regional Study on Selected Brick Kiln Firms”, United States of America Research Journal (USARJ), Volume 2, No 3, ISSN 2332-2160, 2014
- [25] Singh Kushwah RP., Ishwar Chand Sharma., “Energy Efficiency And Value Engineering With Industrial Waste “Marble Slurry, International Journal of Applied Engineering and Technology, ISSN: 2277-212X (Online), Volume 5, Issue 1, 2015, pp.84-89 (1)
- [26] Specifications for and Classification of Brick, “Brick industry Association”
- [27] Status Report On Commercial Utilization Of Marble Slurry In Rajasthan,”
- [28] Swaminathan Dhanpandian., Balasubramani Gnanavel., thirunavukkarasu Ramkumar., “Utilization of Granite and Marble Sawing Powder Wastes as Brick Materials”, Carpathian Journal of Earth and Environmental Sciences, Volume 4, Issue 2, April 2007, p. 147 - 160
- [29] Viswakarma Amit., Rajput Rakesh Singh., “Utilization Of Marble Slurry To Enhance Soil Properties And Protect Environment”, Journal of Environmental Research And Development, Volume 7, Number 4A, April-June 2013 , 1479-1483
- [30] W. Rehman., M. Riaz., M. Ishaq., M. Faisal., “Utilization of Marble Waste Slurry in the Preparation of Bricks”, Journal of Pakistan Institute of Chemical Engineers, Volume 42, Issue 1, Online: 18/07/2014, 47-5
- [31] IS 1077: 1992 for Common Burnt Clay Building Bricks – Specification
- [32] IS 11650: 1991 Guide for Manufacture of Common Burnt Clay Building Bricks by Semi-Mechanized Process
- [33] IS 2212: 1991 Brick Works-Code of Practice
- [34] IS 3495 (Parts 1 to 4): 1992 Methods of Tests of Burnt Clay Building Bricks