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An Overview and Use of Kota Stone Powder Slurry to Improve Engineering Properties of Soil Stabilization

[1]Anjali Verma, [2]Hemant Kumar Sain

[1]M.Tech Student, Department of Civil Engineering, Arya Institute of Engineering & Technology, Jaipur, Rajasthan, India

[2]Assistant Professor, Department of Civil Engineering, Arya College of Engineering, Jaipur, Rajasthan, India

Abstract: Kota city is having major problem of disposing of Kota stone slurry powder. It is any product which is obtained during cutting, grinding and polishing operations of locally available Kota stone in stone industries. One of the innovative ground improvement techniques can be practiced by using Kota stone slurry powder (KSSP) as stabilizing agent or admixture. This technique of may simultaneously offer the other advantages such as space saving, environmental sustainability, material availability etc. In the present study, Kota stone slurry powder is used as a stabilizing material for soil stabilization. The stone slurry waste taken from the stone cutting plant, stone slurry rich in calcium oxide. The study describes the effectiveness of stone slurry waste to stabilize the black cotton soils. The stone slurry waste was mixed with black cotton soils in different proportion and investigates the effect of stone slurry waste on strength, compaction and CBR properties of black cotton soils.

Keywords : Stabilization, Kota Stone Slurry, Soil, Strength, CBR, Kota stones sludge, granite sludge, marble slurry, building stone, replacement material

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I. INTRODUCTION

Kota stone are generally used for cladding of the walls, decorating the floors and many other ways. It is having oil resistant, non-water absorbent, non–slippery and excellent stone resolvability properties. It is available in the form of slabs and tiles. Kota stone deposits spread in some areas of Kota and some part of Jhalawar District in Rajasthan. Fine slurry is produced during cutting, grinding and polishing of the Kota stones in stone industries. Every year approximately 3 to 3.25lakh metric ton of stone slurry is produced and disposed of into local convenient places. This influences about 5 to 10 hectares useful land every year. This waste causes general environmental and economical drawback and health problems. Some of them are enlisted as loss in soil fertility due to increase of alkalinity in soil, contamination of underground water, health problem due to slurry dust suspended particles in air, stone slurry clusters or heaps etc. Kota stone slurry is a semi liquid substance consisting of particles originated from the sawing and polishing process and water is used to cool and lubricate the sawing and polishing machines. Kota stone slurry powder can because as a filler or stabilizing material. Kota stone slurry powder is obtained by drying of Kota stone slurry. Kota stone is basically a flaggy lime stone. This slurry is having the characteristics which are very useful for improving the properties of expansive soil and helps in escalating the solid waste dumping problem [1-2].

II. Importance of Kota stone

- The naturally available stones of Kota bear a different blend of shades that makes them look very attractive and colourful. The Kota stones are used for cladding of the walls, decorating the floors, and in many other ways to beautifully decorate a house. The uses of the multicolored Kota stones add to the grace of the apartment. Kota stones can be used in Exteriors, Pathways, Corridors, Driveways, Balconies, Commercial buildings etc.

- Kota stones are hard, oil resistant, no water absorbent, non slippery and have excellent stone resolvability. They are available in slabs and tiles form.
- It is the cheapest of other natural stones that can easily suit our budget.
- Kota Stone is the ideal flooring material to impart a stronger and luxurious look to the floors.
- It is an excellent building stone for humid regions and freezing regions. Because the Kota stone floors are heavy, they are set on strong base.
- Kota Stone is available in natural shades and can be given customized shapes. It can be cut and shaped as per the requirement.

III. Physical Properties of Kota Stone

Kota Stone are quite impervious, Hard, Compact, fine to very fine grained calcareous rocks of sedimentary nature.

Table 1: Physical Properties of Kota Stone

Compressive Strength	21.75 kg/sq. Mm
Abrasion Resistance	18.12 (Abrasion value)
Oil Absorption	Nil
Water Absorption	0.31 %
Mohr Hardness No.	will scratch -3 Calcite will not Scratch- 2.1/2 Galena
Density	2.5 to 2.65 Kg/m^3
Porosity	Quite Low
Weather Impact	Resistant

IV. Chemical Properties of Kota Stone

Chemically, Kota Stone are siliceous calcium carbonate rocks.

Table 2: Chemical Properties of Kota Stone

Lime (CAO)	38-42%
silica(SiO_2)	20-25%
Alumina (Al_2O_3)	2-4%
Other Oxides like Na, Mg	1.5 to 2.5%
Loss On Ignition (LOI)	30-32%

V. Generation of waste

Indian calcareous stone industry currently produces around 17.8M.T of solid calcareous waste (12.2 M.T as rejects at the mine sites, 5.2 M.T in the form of cutting /trimming or undersize materials and 0.4 M.T. calcareous slurry at processing and polishing units). The polishing is applicable only to marble and flagstones. To accumulate calcareous waste is of the order of 250 M.T. it has become an environmental waste is of the order of 250 M.T. it has become an environmental hazard affecting the land and population over a large area.

The solid waste generated in the calcareous stone industry is directly related with the production and processing of various types of calcareous stones that have drastically increased over the years. It is about 16.5% of the total calcareous stone produced in the country. the waste generated varies from negligible in case of the calcareous stone used in cement industry, 10-20% in case of lime burning industry 20-40% in case of building stone(block and slab) industry,40-45% in case of steel grade limestone and dolomite production and 65-85% in case of marble and flag stone (Kota stone , Cuddapaha Slab and Shahabad stone)used in dimensional and decorative industry . Presently out of 6773 mines of calcareous stone covering an area of about 0.2 million hectares of land. Only about 5400 mines are operating. The production of calcareous stone has gradually increased from 76 M.T. (1989-90) to 97 M.T. (1993-94) and 118.6 M.T. (1996-97). It is expected to touch 139 M.T. by 2000 AD and to 188.6 M.T. by 2005 A.D.

Quarrying of Kota stone and other dimensional stones is being carried out throughout the state and same is being processed at gang saws, single and multi-blade cutters and similar processing units which are spread all across the state only insignificant quantities have been utilized and the rest has been dumped resulting in tremendous increase in generation of stone waste in the form of mine waste, cutting waste and processing/polishing waste which creates environmental problem and health hazards such as:

A. Quarrying and Trimming Waste

- The Cutting waste produced during trimming of edges of the slabs, broken pieces, unsawable blocks, irregular and odd shaped blocks are lying scattered here and there in the mine area as well as in processing units.
- The quarrying waste is just piled up in the areas nearer to quarries by the miners, creating huge mounds of stone waste, thereby destroying the natural vegetation and ecology of the area.
- The quarrying waste is even being dumped on seasonal river beds, thereby threatening the porosity of the aquifer zones.

Fig 1 : Huge Waste Dumps at Kota Stone Mines

B. Slurry Waste

The marble slurry generated during the processing of Kota stone causes the following environmental damage:

- The porosity and permeability of the top soil is reduced tremendously and in due course of time it results in water logging problems at the surface and there by not allowed the water to percolate down. When & where it has happened the ground water level had adversely been affected and it has gone down to deeper levels
- The fine Kota stone dust reduces the fertility of the soil by increasing its alkalinity.
- Waste thus dumped dries out and the fine Kota stone dust suspends in the air and is slowly spread out through winds to the nearby area. It settles down on crops and vegetation, thus severely threatening the ecology of the Kota stone clusters.
- When dumped along the catchment area of natural rain water, it results in contamination of over ground water reservoirs and also causes drainage problem.
- Exposure to dust from industrial activities can lead to various respiratory ailments in nearby residential areas. Pneumoconiosis is a non-cancerous lung disease caused by the inhalation of mineral dust, resulting in structural changes within the lungs. This condition includes disorders such as asthma, bronchitis, and emphysema. Among these, silicosis is a serious and progressive form of pneumoconiosis caused by inhaling silica dust, which damages lung tissue. Mixed dust fibrosis can occur when silica is inhaled along with other non-fibrogenic dusts. Additionally, exposure to minerals like beryllium, talc, kaolin, and mica can also cause lung diseases. Extrinsic allergic alveolitis, such as farmer's lung and malt worker's lung, arises from sensitization to organic dusts like Kota stone slurry dust, leading to lung inflammation and flu-like symptoms. Asthma, commonly triggered by workplace dust allergens, is

characterized by airway inflammation and intermittent muscle spasms, with symptoms including coughing, wheezing, chest tightness, and shortness of breath, which usually improve during weekends or extended breaks from work. Furthermore, certain dusts, such as lead and its salts, can be absorbed into the bloodstream, posing additional health risks.

- The body after inhalation or skin contact. They can then have harmful effects on other organs e.g. the nerves or the blood forming organs. Ultrafine particles might travel through the alveoli to produce harmful affects the fertility.
- It has become a safety hazards on the highways along which it is dumped, due to its slippery nature when wet.
- It also has an adverse effect on the landscape beauty of the area.

Fig 2: Disposal of slurry waste at agriculture land

Fig 3: Disposal of slurry waste near road side

The agriculture land use in Kota district is reducing due to increasing in mining dumps of waste of polishing and cutting of Kota stone industries as well settlement of habitation. The cutting and polishing industries established in area causes a huge waste material dumps in the vicinity. This is causing serious problem, increasing danger both to mining industry as well as habitants. There is a minimum safe zone of 500 m which has to be vacated before conducting any blasting operation. Further movement of heavy earth movement machine expose danger of road side accidents to the families of such inhabitants besides causing environmental problem from dust and fines.

VI. Black Cotton Soil

Black cotton soils are inorganic clays of medium to high compressibility and form a major soil group in India. They are characterized by high shrinkage and swelling properties. This Black cotton soils occurs mostly in the central and western parts and covers approximately 20% of the total area of India.

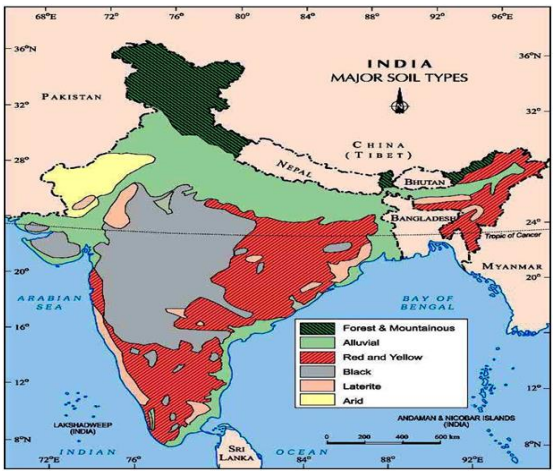

Fig 4: Soil map of India

Generally, lands with black cotton soils are fertile and very good for agriculture, horticulture, sericulture and aquaculture. Good irrigation systems exist, rainfall is high and people are affluent in these areas. Though black cotton soils are very good for agricultural purposes, they are not so good for laying durable roads. Good road network is a basic requirement for the all round development of an area. Unfortunately, poor road network is hampering the full fledged development

of the otherwise prosperous areas. Black cotton soils absorb water heavily, swell, become soft and lose strength. Black cotton soils are easily compressible when wet and possesses a tendency to heave during wet condition. BC soils shrink in volume and develop cracks during summer. They are characterised by extreme hardness and cracks when dry. The stability and performance of the pavements are greatly influenced by the sub grade and embankment as they serve as foundations for pavements. On such soils suitable construction practices and sophisticated methods of design are to be adopted.

Because of its high swelling and shrinkage characteristics, the Black cotton soil (BC soils) has been a challenge to the highway engineers. It is observed that on drying, the black cotton soil develops cracks of varying depth. As a result of wetting and drying process, vertical movement takes place in the soil mass. All these movements lead to failure of pavement, in the form of settlement, heavy depression, cracking and unevenness.

VII. Nature of Black Cotton Soils

Roads running in black cotton soils are known for bad condition and unpredictable behavior for which the nature of the soil contributes to some extent. Nature of black cotton soils is discussed here.

- BC soils absorb water heavily, swell, become soft, lose strength, easily compressible and have a tendency to heave during wet condition.
- BC soils shrink in volume and develop cracks during summer. They are characterised by extreme hardness and cracks when dry.
- Soils are called highly expansive when Free Swell Index exceeds 50%. Such soils undergo volumetric changes leading to pavement distortion, cracking and general unevenness due to seasonal wetting and drying.
- BC soils produce a CBR value of 2 to 5% if compacted efficiently.

VIII. Conclusion

In this Paper give an overview of the Kota stone slurry powder is used as a stabilizing material for soil stabilization. The stone slurry waste taken from the stone cutting plant, stone slurry rich in calcium oxide. The study describes the effectiveness of stone slurry waste to stabilize the black cotton soils. The stone slurry waste was mixed with black cotton soils in different proportion and investigates the effect of stone slurry waste on strength, compaction and CBR properties of black cotton soils.

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