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Sand and its importance in Saudi Arabia and methods of its preservation

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ABSTRACT

Sand is a valuable natural resource in Saudi Arabia it commonly used to form beaches and places for recreation. It's used to make windowpanes, cell phone screens, and sunglasses. Concrete and asphalt both come from sand. And the industrial uses of sand-to fill holes, make molds, and create traction-are seemingly endless. It's the second-most exploited resource after water, and the world is running. The sand in Saudi Arabia exposed to sever decrease in its amounts due to the using of the san in the construction of buildings. Our study concluded that, the sand in Saudi Arabia constituted a great wealth value and must be take a good preservation on it, the study cleared that, the most important methods for preservation of the sand includes, running out of sand, using of waste sand, using stabilized soils, cement was used as a stabilizing agent and utilization of dune sands as a construction material.

Keywords: Sand, Saudi Arabia, preservation

* INTRODUCTION

Natural resources are becoming more strained each year as more people lay claim for the consumption and demand a higher standard of living. As countries search for more resources to exploit, an enormous toll is being taken on the planetary resources (Benaafi and Abdullatif, 2015).

The growth of population in many parts of the world is putting pressure on the limited natural resources in the whole planet. The growing population and the automation of transport is putting pressure on available petroleum reserves. (Al-Husseini, 2004).

Sand: is anatural resource that used to form beaches and places for recreation. It's used to make windowpanes, cell phone screens, and sunglasses. Concrete and asphalt both come from sand. And the industrial uses of sand-to fill holes, make molds, and create traction-are seemingly endless. It‟s the second-most exploited resource after water, and the world is running out of it. Facing a shortage of sand, many countries-from the US to the United Arab Emirates are dredging ocean bottoms for sand, nearly destroying aquatic ecosystems in the process. As The New Yorker reports, "Seafloor dredging creates the undersea equivalent of choking sandstorms, killing organisms, destroying coral reefs and other habitats, and altering patterns of water circulation." (Al-Sayyari and Zotl, 1978).

Saudi Arabia is one of the richest countries in the world in terms of unconsolidated sand and sandstone reserves. In general, the sedimentary section of the Arabian Shelf is of shallow water origin with large quantities of sandstone, shale, and limestone composition. The recent quaternary age deposits include silt, sand, pebble limestone, and some basement complex classics. The thickness of recent alluvium varies from location to location. The huge blanket of sand (Aeolian deposits) covers most of Saudi Arabia. The enormous Rub Al-Khali desert, also known as sand sea, is one of the largest dune systems covering 600,000 sq. km across Saudi Arabia, Yemen, Oman, and the United Arab Emirates (Garzanti et al. 2003). Shamal winds are responsible for carrying heavy bed loads in the form of dust, resulting in sand dune formation in this basin. The dominant sediment composition of Rub Al-Khali sand sea is 90% quartz; the rest is feldspar and iron oxide (Edgell 2006). Quaternary sand deposits in Saudi Arabia were discussed by Jado and Zotl (1978). Recent studies on sand dune characterization were conducted by (Benaafi and Abdullatif, 2015).

Scientific sources say that the concentration of scientific research sources in the sands of some regions of the Kingdom reaches 99.9%. The sand in the Kingdom is one of the types that were deposited during time, and it is

devoid of impurities that are avoided by precision industries, such as making molds for electronic devices. (Benaafi and Abdullatif, 2015).

News that more than 10 thousand million tons of white sand in Saudi Arabia, the element silicon in it. Information from the Kingdom's Ministry of Energy, Industry and Mineral Resources indicates negative consequences for sand mining. One of them is that it reduces the vegetation cover that was formed thousands of years ago, destroys the natural environment for some types of wildlife, leads to increased desertification and a high level of dust spread that affects public health. As a result, the kingdom banned the export of sand and gravel outside the kingdom. (Galetakis et al., 2012).

For saving the sand using in construction the substituets of sand must be used in the bulding construction as, manufactured sand, also, Concrete recycling and use again. These are currently used in primary road bases. Recycling glass and using it as sand, which is as strong as natural sand, saves 14% of the total cost, and reduces carbon dioxide emissions by 18%. When glass waste is crushed (Benaafi and Abdullatif, 2015).

*** Objectives and Methodology**

This study aimed to study the sand its importance and methods of its preservation in Kingdom of Saudi Arabia.

The methods that used for preservation of sand includes (Benaafi and Abdullatif, 2015).

1- Running out of sand
2- Using of waste sand:
3- Using stabilized soils
4- Cement was used as a stabilizing agent
5- Utilization of dune sands as a construction material

*** RESULTS AND DISCUSSION**

A- Sand and its importance

Saudi government organizations have also been paying greater attention to sustainability in recent years (Alrashed, F.; Asif, 2014 and Alyami et al., 2015). A tangible example of this is Saudi Vision 2030, which takes a huge positive step towards implementing sustainability (Saudi Arabia's Vision for 2030). In addition, it is recommended that tools tailored for sustainable assessment of Saudi Arabian homes be developed from within (Taleb and Sharples, 2011). Additionally, it is recommended that such innovative tools be employed by building owners so that they can manage construction decisions (including renovation projects)

sustainably, especially when they own a large portfolio of buildings (Nielsen et al., 2016).

Sand has been used for construction since 7000 BCE, but its use ramped up at the turn of the 20th century. "Once it was perfected — wham — it just took over the entire planet," Beiser tells RN's Saturday Extra. Concrete, which is made out of sand and gravel, is now used to make our buildings, shopping malls and roads. (Alyami et al., 2015).

*** Methods of sand preservation**

1- Running out of sand

Sand from the desert is unsuitable for construction, so instead we mostly use sand found at the bottom of rivers, lakes, oceans and on beaches. Beiger says the world uses 50 billion tons of this kind of sand every year — more than any other natural resource, "except for water". "When you are talking about quantities that large, sooner or later you're going to run into shortages, and that is in fact what is happening in a growing number of places around the world," he says. (Galetakis et al., 2012).

2- Using of waste sand

Saudi Arabia has huge reserves of sedimentary rocks, mainly limestone and dolomite rock in the central and eastern regions. Soft limestone and dolomite produce more waste during the cutting, crushing, and washing stages than granite and basaltic rocks. An enormous number of aggregates were produced for concrete and road application from different quarries located in the Eastern region of the country. As most of the rock in this region consists mainly of soft limestone and dolomite, a huge amount of waste sand is produced during the cutting, crushing and washing stages for the production of aggregates (Amin et al., 2017).

Consequently, this waste causes severe environmental and health hazards during sandstorms in these areas. Therefore, there is a need for proper utilization of the waste for different applications in the construction industry to minimize the related environmental and landfill issues. Many researchers have investigated its beneficial use as a cement replacement and a fine-aggregate replacement in concrete production (Sureshchandra et al., 2014).

However, the utilization of the quarry waste in concrete industry is very small compare to the overall waste production. Furthermore, there is a massive network of roads and highways spread all over the country that needs a huge amount of earth materials. Therefore, there is a need to

investigate the effectiveness of using waste sand in road construction as an alternative to natural material, especially in the eastern part of the country where easily accessible quarries are widely spread. Cement is considered the most conventional additive, being used for purposes of soil stabilization (Li et al., 2015).

Several studies were carried out to investigate the effect of cementitious additives (steel slag, Portland cement, lime, fly ash, gypsum, cement slag, aluminum filler, marble dust, and magnesium oxides) on the engineering properties of soils used for road construction and foundations (Mashhadban et al., 2016).

Most of these studies showed a considerable increase in strength and stiffness and a decrease in the swelling potential and compressibility of the treated soils. In particular, sandy soils were investigated as base and sub-base materials for road construction by using different types of additives to improve the materials mechanical and engineering properties. Dune sand collected from Jeddah, Saudi Arabia, and treated with Portland cement showed a strong correlation between cement content and the CBR (California bearing ratio) for both confined and unconfined conditions (Querol et al., 2017).

Tests on graded aggregates for high-speed railway road foundation found that the binding effect of cement is more dominant than the filling effect, and the optimum cement content was estimated to be 5% (Guotang et al., 2017). Recent work on the effect of using nanosilica as a stabilizer showed that adding the optimum amount of nanosilica to cement-stabilized sand soil improved its mechanical and microstructural properties (Choobbasti et al., 2017).

3- Using stabilized soils

Other studies focused on many other aspects concerning stabilized soils used in road construction. These included mixture design, testing procedures, practice and control during construction, and adequacy of classification and specification of the material used for stabilization considering different methodologies of design supported by laboratory or field-testing programs (Celauro et al., 2012). No attention was given to the use of waste sand as a construction material, especially not to its use in road foundations. (Gomez and Anderson, 2012).

4- Cement was used as a stabilizing agent:

Cement was used as a stabilizing agent to improve the engineering properties of the waste

sand as a base course material in road construction projects. Different percentages of Portland cement (2, 4, 6, and 8% of the dry weight of the waste sand) were selected. The sand used in this study was collected from one of the quarries in the Al-Ahsa area (East Province, Saudi Arabia). (NLA, 2006).

5- Utilization of dune sands as a construction material

Because of the dry continental climatic conditions, nearly one-third of Saudi Arabia is covered by active dune fields, representing the largest continuous body of aeolian sand on earth (800,000 km2 of 2.3 million km2, USGS 1963; Garzanti et al. 2013).

Mostly, these sands are concentrated in the eastern provinces and Arabian Shield. Generally, the sand dunes of Saudi Arabia are restricted to the Arabian Shield and its wadi courses, which cut through Precambrian igneous and metamorphic rocks (Al-Harthi 2002). These sand dunes are growing, migrating and causing problems for the expansion of cities, roads, and power and communication lines. In the studied area, owing to the migration of dune sands, serious geo-environmental risks have developed for urban areas and road construction. The western regions of Saudi Arabia are characterized by a rareness of fine natural aggregate resources. At the same time, these desert areas involve construction activities that require many aggregates. Because of the remoteness of the construction sites from aggregate production quarries in these areas, transporting aggregates is expensive and uneconomical. In addition, engineers face the difficulties of a more restricted choice of materials in these regions (Amjad 1989; Al-Harthi 2002; Al-Fredan 2008).

Therefore, these sand dunes are considered a vital source of fine aggregates for use in construction material for producing concrete, mortar and pavement material. Fine aggregate usually constitutes about one-third of the total volume of concrete aggregates, where it fills the space between coarse aggregates. Also, fine aggregate (sands) makes up the main bulk of masonry mortar; therefore, it has a significant effect on the properties of the product in both the fresh and hardened state. Moreover, fine aggregates play a vital role in providing the fineness and cohesion of concrete. We reviewed similar research published in the last decades (e.g., Khan 1982; Al-Sanad and Bindra 1984; AlSanad et al. 1993; Al-Abdul Wahhab and Asi 1997; AlHarthy et al.

2007; Alhozaimy et al. 2012; Abu Seif 2013a, b; Elipe and Lo´pez-Querol 2014), which was applied to evaluate dune sands as a construction material, pavement aggregate and replacement soil layer. The mechanical properties of these mixes (concrete and mortar) are affected by the strength of the dune sand-cement-aggregate bond and by various factors such as the texture and chemical stability of these components. This work presents the results of extensive field and laboratory tests carried out to assess dune sands with respect to their use as concrete and mortar fine aggregates.

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*** REFERENCES**

Abdulkadir, A., and Abdullatif, O. 2013. Facies, Depositional Environments, Reservoir Potential and Paleogeography of the Cambro-Ordovician Dibsiyah Formation, Wajid Outcrop Belt, Saudi Arabia. Arabian Journal of Science and Engineering 38 (7): 1785–1806.

Al-Husseini, M.I. 2004. Pre-Unayzah unconformity, Saudi Arabia. In Carboniferous, Permian and Early Triassic Arabian Stratigraphy: GeoArabia Special Publication 3, ed. M.I. Al-Husseini, 15–59. Bahrain: Gulf PetroLink.

Alrashed, F.; Asif, M. Saudi building industry's views on sustainability in buildings: Questionnaire survey. Energy Proced. 2014, 62, 382–390.

Al-Sayyari, S.S. and Zotl, J.G. 1978. Quaternary Period in SaudiArabia, Volume 1: Sedimentological, Hydrogeological, Hydrochemical, Geomorphological, and Climatological Investigations in Central and Eastern Saudi Arabia. Vienna: Springer-Verlag/Wien.

Alyami, S.H.; Rezgui, Y.; Kwan, A. The development of sustainable assessment method for Saudi Arabia built environment: Weighting system. Sustain. Sci. 2015, 10, 167–178.

Amin, M.N.; Khan, K.M.; Saleem, U.; Khurram, N.; Niazi, M.U. Aging and curing temperature

effects on compressive strength of mortar containing lime stone quarry dust and industrial granite sludge. Materials 2017, 10, 642.

Amin, M.N.; Khan, K.M.; Saleem, U.; Khurram, N.; Niazi, M.U. Aging and curing temperature effects on compressive strength of mortar containing lime stone quarry dust and industrial granite sludge. Materials 2017, 10, 642.

Benaafi, M. and Abdullatif, O. 2015. Sedimentological, mineralogical, and geochemical characterization of sand dunes in Saudi Arabia. Arabian Journal of Geosciences 8 (12): 11073–11092.

Celauro, B. Design procedures for soil-lime stabilization for road and railway embankments. Part 1-Review of design methods. Procedia Soc. Behav. Sci. 2012, 53, 755–764.

Choobbasti, A.J.; Kutanaei, S.S. Microstructure characteristics of cement-stabilized sandy soil using nanosilica. J. Rock Mech. Geotech. Eng. 2017, 9, 981–988.

Edgell, H.S. 2006. Arabian deserts: nature, origin, and evolution. Dordrecht, The Netherlands: Springer.

Evans, D., Lathon, R., Senalp, M. et al. 1991. Stratigraphy of the Wajid Sandstone of Southwestern Saudi Arabia. Presented at the Middle East Oil Show, Bahrain, 16 –19 November. SPE-21449-MS.

Galetakis, M.; Alevizos, G.; Leventakis, K. Evaluation of fine limestone quarry by products, for the production of building elements—An experimental approach. Constr. Build. Mater. 2012, 26, 122–130.

Garzanti, E., Ando, S., Vezzoli, G. et al. 2003. From rifted margins to foreland basins: investigating provenance and sediment dispersal across Desert Arabia (Oman, U.A.E.). Journal of Sedimentary Research, 73 (4): 572–588.

Gomez, J.N.; Anderson, D.M. Soil cement stabilization- mix design, control and results during construction. In Proceedings of the International Symposium on Ground Improvement, Brussels, Belgium, 31 May–1 June 2012.

Government of Saudi Arabia. Saudi Arabia's Vision for 2030; Saudi

Vision 2030: Saudi Arabia; 2016. Available online: https://vision2030.gov.sa/sites/default/files/report/Saudi_Vision2030_EN_2017.pdf (accessed on 3 April 2017).

Guotang, Z.; Wei, S.; Guotao, Y.; Li, P.; Degou, C.; Jinyang, J.; Hao, H. Mechanism of cement on the performance of cement stabilized aggregate for high-speed railway roadbed. Constr. Build. Mater. 2017, 144, 347–356.

ISO 13503-2, Petroleum and natural gas industries -- Completion fluids and materials -Part 2: Measurement of properties of proppants used in hydraulic fracturing and gravel-packing operations. 2006. Geneva, Switzerland: ISO.

Jado, A. and Zotl, J.G. 1978. Quaternary Period in Saudi Arabia, Volume 2: Sedimentological, Hydrogeological, Hydrochemical, Geomorphological, and Climatological Investigations in Western Saudi Arabia. Vienna: SpringerVerlag/Wien.

Li, D.; Liu, X.; Liu, X. Experimental study on artificial cemented sand prepared with ordinary Portland cement with different contents. Materials 2015, 8, 3960–3974.

Little, D.N.; Nair, S. Recommended Practice for Soil Stabilization; National Cooperative Highway Research Program (NCHRP): Washington, DC, USA, 2007; p. 144

Mashhadban, H.; Beitollahi, A.; Kutanaei, S.S. Identification of soil properties based on accelerometer records and comparison with other methods. Arabian J. Geosci. 2016, 9, 1–8.

Nielsen, A.N.; Jensen, R.L.; Larsen, T.S.; Nissen, S.B. Early-stage decision support for sustainable building renovation—A review. Build. Environ. 2016, 103, 165–181.

NLA. Mixture Design and Testing Procedures for Lime Stabilized Soil; Technical Brief; National Lime Association: Arlington, VA, USA, October 2006

Powers, R.W., Ramirez, L.F., Redmond, C.D. 1966. Geology of the Arabian Peninsula: sedimentary geology of Saudi Arabia. Washington, DC: USGS. Professional Paper 560D.

Querol, S.L.; Trujillo, A.A.; Elipe, M.G.; Sanchez, A.M.; Cantero,

B. Improvement of the bearing capacity of confined and unconfined cement-stabilized aeolian sand. Constr. Build. Mater. 2017, 153, 374–384.

Stump, T.E. and Van der Eem, J.G. 1995. Overview of the Stratigraphy, Depositional Environments and Periods of Deformation of the Wajid Outcrop Belt, Southwestern Saudi Arabia. Journal of African Earth Sciences 21 (3): 421–441.

Sureshchandra, H.S.; Sarangapani, G.; Kumar, B.G. Experimental investigation on the effect of replacement of sand by quarry dust in hollow concrete block for different mix proportions. Int. J. Environ. Sci. Dev. 2014, 5, 15–19.

Sureshchandra, H.S.; Sarangapani, G.; Kumar, B.G. Experimental investigation on the effect of replacement of sand by quarry dust in hollow concrete block for different mix proportions. Int. J. Environ. Sci. Dev. 2014, 5, 15–19.

Taleb, H.M.; Sharples, S. Developing sustainable residential buildings in Saudi Arabia: A case study. Appl. Energy 2011, 88, 383–39.