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Geology & Engineering Properties of Nagar Parkar Granites, District Tharparkar, Sindh, Pakistan

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Abstract:
The Nagarparkar igneous rocks (The latitude for Nagarparkar, Pakistan is: 24.360474 and the longitude is: 70.758477) are locateded in the southern end of the Tharparkar desert near the Runn of Kutch, comprising an area of about 500- 1000 sq. km. It is surrounded by Indian border on three sides, just like forming an enclave of Pakistan within India. There is a metalled road from Hyderabad to Nagarparkar, which is near about 500 kms, leading from. Hyderabad - Badin - Mithi - Islamkot – Nagarparkar andNagarparkar can also be reached via Karachi, as Karachi - Thatta - Sujawal - Badin - Mithi - Islamkot - Nagarparkar. The third way to Nagarparkar is also at the Coastal Highway, the new road has been built. It connects Karachi with Nagarparkar via KetiBundar - Badin - Nagarparkar. Nagarparkar area contains mainKarunjhar hill and separeated hillocks or ridges of limited aerial extent, surrounded by sand and clay covered plains. These hillocks alsocompriset of 8 to 10 varieties of pink and grey coloured granites. The smaller rock bodies are known asVoravoh, Churio, Berano, Parodharo, Dhedhvero, Dhingano, Chanida, Densi, Wadhrai, Ranpur and Kharsar, amongst others. The Nagar Parkar complex is composed of wide spread spherical and subroundedhillrocks sharing Bright,Pink granites, it is geochemically containing , Na, Fe, Mg, Al, Zr oxides, etc. (Jan M.Q et al:2014, 2016, 2017, 2018), de wakk et al 20018, Ali.M etal, 2012, and Ahmed S.M et al 2007. This is the first time study of Nagar Parkar Granites related to the Engineering properites. Nagar Parkar Granites are located at Nagar Parkar Town along the Northe-Eastern margin of karonjhar hill, while the other ridges are spread in Bhodisar, Voravoh, Churio, Berano, Parodharo, Dhedhvero, Dhingano, Chanida, Densi, Wadhrai, Ranpur and Kharsar, amongst others.. The granites has medium to coarse grains, majority homogeneous and leucocitic. It shows sperical weathering, with porphiritic dykes and deteritic dykes, near Bhodisar temple. The paper presents the Geology of the granite along with Engineering properties of selected samples to find the recommendation for construction industry.Geologically there is a variety of Quaternary deposits, subordinate and scattered Jurasic – Tertiary sandstones and clays, overlying a basement that is termed as the Nagar Igneous Complex. It is divided into Dhedvero basic intrusion, Nagar pink granite and Karunjhar grey granite.

I. INTRODUCTION

The Nagarparkar igneous complex is exposed in the southern extremity of the Tharparkar desert near the Runn of Kutch, covering an area of approximately 1000 sq. km. It is surrounded by Indian territory on three sides, thus forming an enclave of Pakistan within India. The road from Hyderabad to Nagarparkar is metalled, which is near about 475 kms, e.g. Hyderabad - Badin - Mithi - Islamkot - Nagarparkar. Likewise Nagarparkar can also be reached via Karachi, Karachi - Thatta - Sujawal - Badin - Mithi - Islamkot - Nagarparkar.

Nagarparkar is also at the other extremity on the Coastal Highway, the new road under construction. Its earth work is completed. It connects Karachi with Nagarparkar via KetiBundar - Badin - Nagarparkar. Nagarparkar area comprises of main Karunjhar hill and isolated hillocks of limited aerial extent, surrounded by sand covered plains. The hillocks predominantly consist of 8 to 10 varieties of pink and grey coloured granites. The hillocks include Voravoh, Churio, Berano, Parodharo, Dhedhvero, Dhingano, Chanida, Densi, Wadhrai, Ranpur and Kharsar, amongst others. Geologically there is a variety of Quaternary deposits, subordinate and scattered Juro – Tertiary sandstones and clays, overlying a basement that is termed as the Nagar Igneous Complex. It is divided into Dhedvero basic intrusion, Nagar pink granite and Karunjhar grey granite.

Geological setting:-

The Nagar Parkar complex is situated extreme south –east of Thar District and desert of Sindh province Pakistan, Near the Run of Katch (24 15'- 24 30' latitude, 70 37'- 71 07' Longitude, it is spread on about 500-1000 sq.Km (Fig.1) . The geology of the are and petrographic study has been covered by various workers Ali, M., Shariffet. Al. 2012. All these researchers concluded that Nagar Parkar Granites,is a part of Indian Shield and an extension of the post Aravali magnetism taken place in the late proterozoic. The major outcrops are near sardhro and BhanbhanjeeDongri, chorio, voravah, kera ,Rarko, Adhigom, Mau.Choriograninte is a seprated out crop in churio and voravoh, it is hard strong coarse granite, grey , light pink in colour and are the second largest hillrocks of the area .

MAP OF NAGAR PARKAR

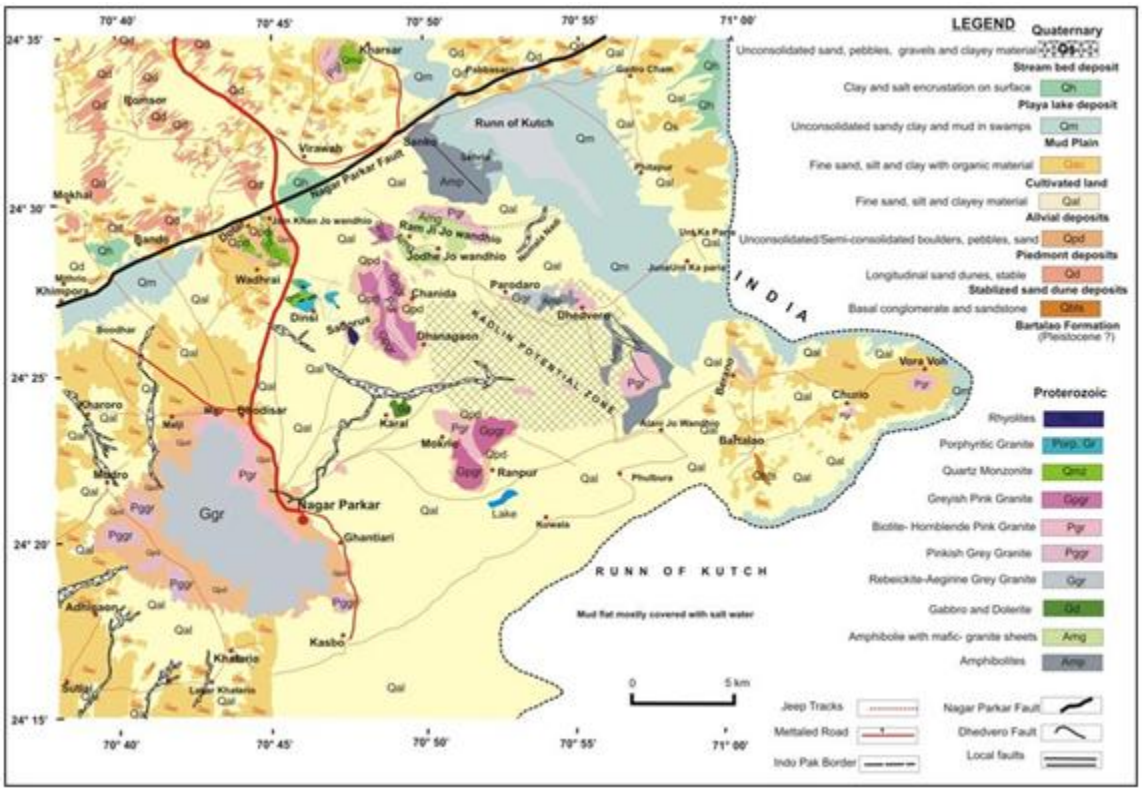
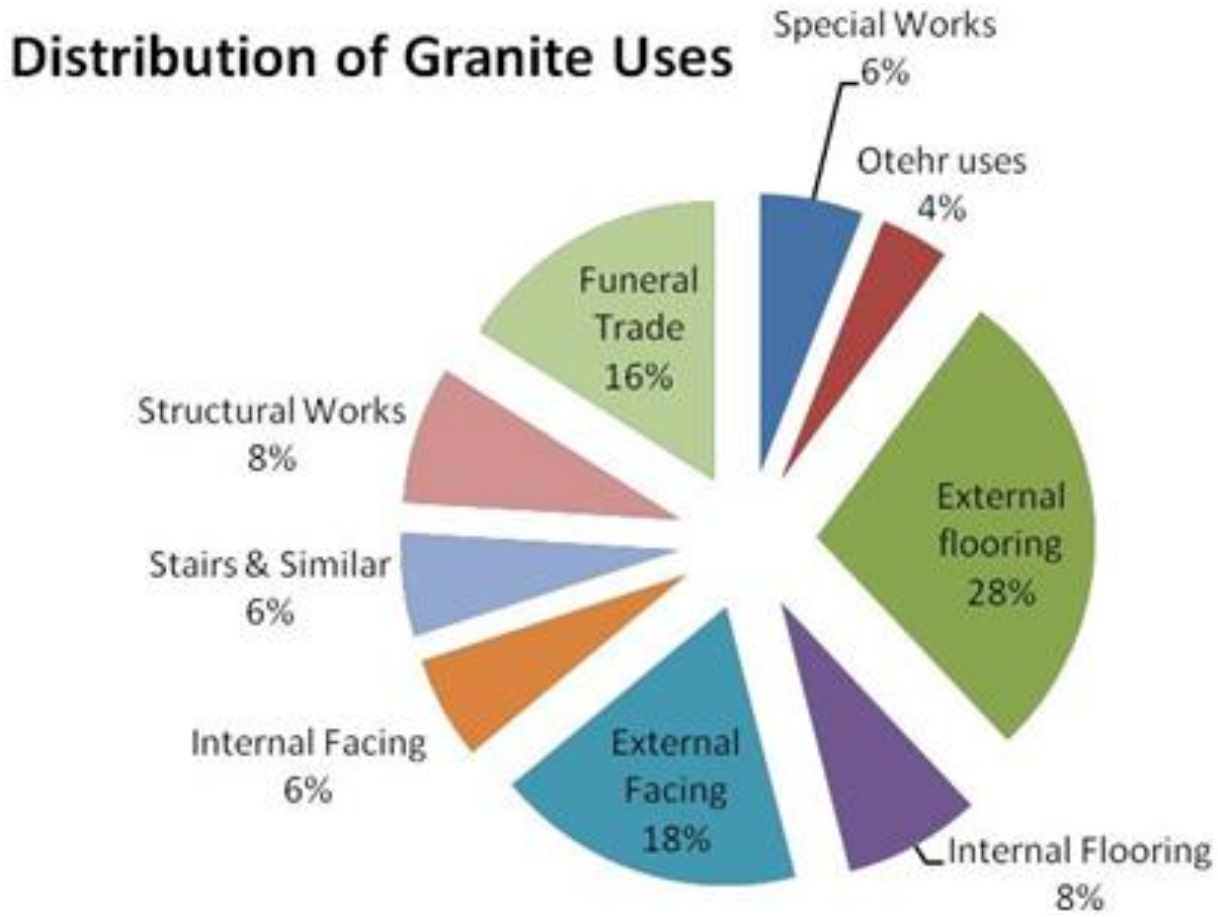


Figure.1. Geological map of Nagar Parkar (modified after Muslim et al., 2006)



DISTRIBUTION OG GRANITE USES IN PAKISTAN

(Ref :Sindh Board of Investment, Government of Sindh, Pakistan, Pre-Feasibility study Project 2010)

The geological succession of the rocks of Nagar Parkar Granite modified after Jan M Q 2014 as under:

Group	Rock deposits	Age
Unconsolidated	Stream bed and flood plain deposits	Recent
Deposits	And evaporite deposits, out wash, piedmount/sub piedmount	Eocene – Recent
Sedimentary Rocks	Aeoline sand deposit, Ran of Kutch mud deposits, Residual deposits/Laterite kaolinite, Bara	Creataceous – Eocene
Nagar Parkar Igneous Rock	Basic dykes, Rhyolites, Acid dykes, Pink Granites, Grey Granites,	Late Proterozoic
	Basement Rock	Proterozoic

The latest granite reserves have been estimated by Geological Survey of Pakistan 1977-78 as under (Muhammad, A. and Alizai, A.H., 2007)

.Grey Granite	11811 Million Tons
Pink Granite	3813 Million Tons
	240 Million Tons
Total 15864 Million Tons	

II. MATERIALS / METHODS:-

For the combined study of the collected sample from field both geological and engineering lab techniques have been used to find the properties of Pink granite and Grey Granite on selected samples, a systematic description of rocks has also been given. Construction aggregate vary in their origin right from the sedimentary ,Metamorphic ,Igneous, provided that is easily available in the vicinity of the area which may be more economical, which is used in both concerete and asphalt for construction of highways, bridges , houses, dams, and other civil structures. (Barrientos et al 2010)Aggregates vary in size from large to small, i-e boulder, clay used in pottery etc. Some large boulder- crushed stone are used in pavement (about 90 – 80%) and binder such as asphalt and cement, while sand and gravel .Aggregates are not only used for foundation, but are used In different phases of construction, For road construction the intact and strong material is recommended, wheather it is suitable or not , there are several consideration. Aggregate used in wearing course must be strongly resistant to the function of vehicle types. There are number of properties for determining the suitablity of rocks just like compressive strength, abrassion, ressistant, water absorption, resistance to weathering, Flakiness etc. Petrographic analysis shows the mineral grains and their shape, size, compostion ,ect, while engineering properties are evaluated by a series of labt tests, like (AAV) Aggregate abrasion value (AIV) aggregate impact value, and (ACV) Aggregate Crushing Value, Specific gravity was determined by ASTM D-854-92, While abrasion Test was performed by Loss Angels machine. Environmental expert observation is also kept under consideration.

III. RESULTS

Sample-1: PINK GRANITE

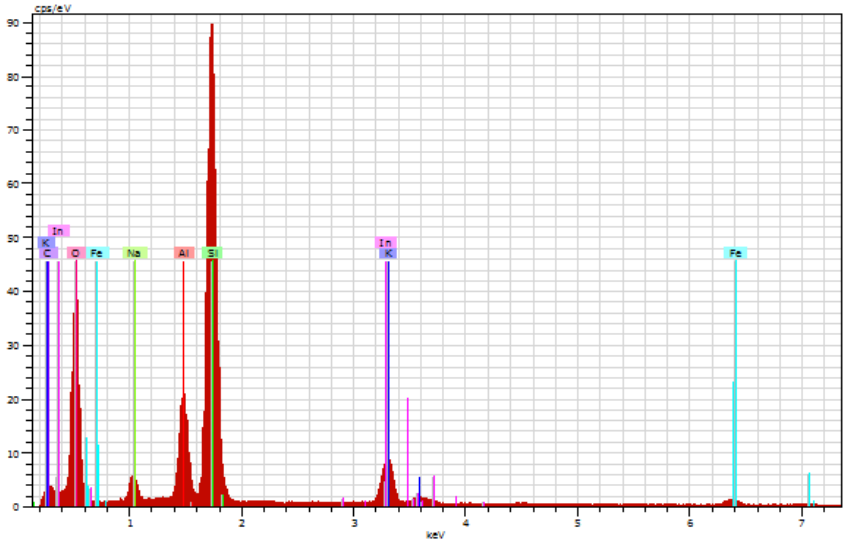


Figure.1. A. E D S Model composition of Granite

Spectrum: Acquisition

Element	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error [%]
Carbon	K-series	2.98	2.83	4.83	0.9
Oxygen	K-series	50.51	48.02	61.43	5.8
Sodium	K-series	3.87	3.68	3.28	0.3
Aluminium	K-series	8.35	7.94	6.02	0.4
Silicon	K-series	30.64	29.13	21.23	1.3

Sample-2

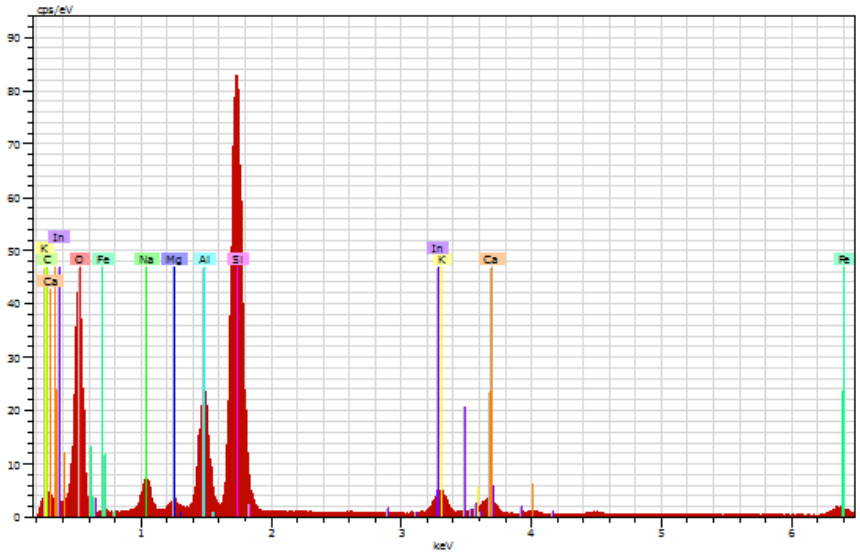


Figure.2. Bgrey Granite

Spectrum: Acquisition

Element	Series	unn. C [wt.%]	norm. C [wt.%]	Atom. C [at.%]	Error [%]
Carbon	K-series	0.63	0.64	1.09	1.1
Oxygen	K-series	49.29	49.79	64.11	5.7
Sodium	K-series	4.25	4.30	3.85	0.3
Magnesium	K-series	1.09	1.10	0.93	0.1
Aluminium	K-series	8.54	8.63	6.59	0.4

Table.A. Strength properties of nagar parkar granites

Rock Sample	AAV %	AIV%	ACV%	Water Absorption	Specific Gravity
Biotite-Granite	22.0	23.0	19.6	0.53	2.7
K-hill	23.4	21.8	25.7	0.61	2.7
Chorio	30.3	29.7	29.4	0.71	2.7
Voravo	29.7	28.00	25.9	0.62	2.6
Runpur	<30	<35	<30	<1.0	2.6

Table .B. Granite Properties

	Crush .Stone PSI	**T st PSI**	**Shear Strenth PSI**
Pink Granite Micro/Fine	4000	470.5	769
Gray Granite Porphyritic	8625	818	1560
	3994	841	2465
Combined Granite	15920	843	1785

Table.C. Values Of Crush Stone, T.S , Water Absorption And Specific Gravity

S.No	Location	C.S PSI	T.S PSI	WA%	Sp.G	Dry Density
1	K.Hill	17000	1750	0.7	2.71	2.67
2	Chorio	16000	4295	0.6	2.81	2.69
3	Volavoh	16500	2040	0.8	2.75	2.7 2.86

Figure.3. Nagar parkar granites sample & varieties used in construction in sindh pakistan.

GRANITE PROPERTIES

PINK GRANITES

IMPACT VALUE (%)	CRUSHING (%)	LOSE ANGLES ABRESSION (%)	SAMPLE
14.6	16.9	18.1	K-HILL
12.7	14.8	17.8	CHORIO
13.5	15.6	18.5	VORAVO
12.8	14.7	18.2	RUNPUR

GREY GRANITES

IMPACT VALUE (%)	CRUSHING (%)	LOSE ANGLES ABRESSION (%)	SAMPLE
14.2	16.7	18.0	K-HILL
12.3	14.6	17.5	CHORIO
13.4	15.3	18.3	VORAVO
12.6	14.3	18.1	RUNPUR

The standard L.A.A Test is AASHTO 96 or ASTM 131 (Resistance to degration)

IV. DISCUSSION

The Nagar Parkar area covers 500-1000 km2 and is located at the midpoint of the Great Rann of Kutch and Thar Desert. It is exposed as mounds and rigid hills of granitic rocks in a sandy, silty and clay covered area (Lagharil, A et al 2015). The rock body is an uplifted batholith of Precambrian igneous rocks that have been named the Nagar Parkar igneous complex by various geologists since the first geological survey in early 19th century. The oldest rocks form an association of low-grade metamorphosed mafic, intermediate, and felsic lithologies which constitute the basement for Neoproterozoic granitic intrusions. The basement rocks are physiographically not prominent and, because of weathering and erosion, commonly occupy low ground between the granite hills. The granites occur in the form of stocks, bosses and dykes and are invaded by felsic, mafic and rhyolitic sheets, dykes and veins. Our earlier preliminary studies (Jan et al., 2017) showed that the complex is composed of six main magmatic pulses. In geological order, these are: basement rocks, riebeckite-aegirine grey granite, biotite-hornblende pink granite, felsic dykes, rhyolite "plugs", and basic dykes. Among these, the granites are dominant over the other rock types. This subdivision is oversimplified and needs to be improved. For example, later workers have reported that the granitoids are also represented by sizable bodies of quartz monzonite (Laghari, 2004; Ahmad & Chaudhry, 2008). Over the past few years, the authors have been engaged in detailed mapping of the area, along with its petrography and geochemistry. Four of the larger bodies of the complex have now been studied in detail (Fig. 1). Though some of the earlier findings for the basement and the two major types of granites (grey and pink) are substantiated, the history of the complex appears to be more complex for the remaining magmatic and volcanic phases that intrude the granites. The felsic dykes, for example, seem to have been intruded over a wider span of time than previously thought. few of them are closely related to the granite bodies and are older than the mafic dykes and rhyolite(Sharma, R. and Kumar, N., 2017). Others seem to be contemporaneous with the latter two, resulting in mutually cross-cutting relations.Whilein the northern part of the Ranpur body, it seems that there were two consequent phases one by one of mafic and microgranite dykes in granite. This, is a petrographic diference in the mafic dykes, shows the possibility of more than one phase of mafic as well as felsic magmatism (Butt, K.A., Jan, M.Q. and Karim, A., 1994). Earlier studies described that the rhyolites occur as plugs and domes, for example the CHRIO body shows several dykes of mostly porphyritic rhyolites, intimately associated with mafic and felsic dykes in the RUNPUR body. The Voravo quartz monzonite body contains the longest (2 km) of the rhyolite sheets in the entire Nagar Parkar complex. The field observation depicts highly complex and multi-phase intrusive activity for the Nagar Parkar igneous rocks. (Sri Ravindrarajah, R. and Tam, C.T., 1985) The result of engineering properties confirms that all are satisfactory according to international standards i.e ASTM & AASHTO, the material is suitable for construction industry if exploited with modern mechanical techniques.(Irfan, T.Y., 1994.)Binici, H.,et. Al 2008.

ECOLOGY: Mining is not a heavy industrial activity in the area, but a small scale activity by local contractors is working that involves road construction and the use of heavy machinery, wildlife is not dislocated and habitat cannot be damaged or destroyed. Birds and other wildlife is not affected seriously after drinking little contaminated water in tailings ponds. In NagarParkar, the topography of the area has a little vegetation which is not suitable habitat for wildlife and other ecological demands. The annual rainfall is very low.

SOIL POLLUTION: The hard rock mining operation itself and the subsequent mineral processing activities resulted waste materials during both which aim to concentrate the minerals of value from the surrounding waste rocks or gangue minerals. Close to an old mine site there may be spoil heaps composed of large blocks of rock by the xenobiotic (human-made) activities or other alteration in the natural soil environment in Soil contamination is noticed as little because of the presence of. It is typically caused not by industrial activity, agricultural chemicals, or improper disposal of waste. Some noticeable types of Poorly vegetated soil types as lack of soil, and easily drain and also have high levels of metal contamination either locked within mineral grains or through contamination of the water

V. CONCLUSION

The Geological survey of Pakistan Pakistanhasgiven an estimate of over 297 billion tons of granite reserves and more than 25 types of various colours and verities of granite are available in Nagar Parkar area Sondh Pakistan. This study has been carried out for providing an information to the potential investors that would help them in preparing complete business plan for the selected quarry. Granite is igneous rock of visible crystalline formation and texture. The general composition of Granite is feldspar (usually potash feldspar and oligoclase) and quartz, with a small amount of mica (biotite or muscovite) and minor accessory minerals, such as zircon, apatite, magnetite, ilmenite, and sphene. Granite has mainly two dominant colours as whitish

or gray with a speckled appearance caused by the darker crystals. Granite is mainly preferred for its use in the exterior applications including flooring tiles trade, highway construction, cladding of lodges and building etc. The specific gravity of Granite ranges from 2.63 to 2.7. Granite has greater strength than sandstone, limestone or Marble and is correspondingly more difficult to quarry. It has become an important building stone, and is used in the external flooring and facing followed by internal flooring. It is more strong, durable as compared to Marble and is economical in maintenance. Granite does not need re-polishing once it is polished and fixed at the desired place, while Marble needs polishing every year or at least once in two years. It is less-porous because of hard compacted granular formation. Because of very low porosity, it does not absorbs water for this property it is mostly used in kitchens, bath rooms and research labs including other offices etc. The construction industry throughout world depends upon the upply of aggregates they are used in all civil projects like, buildings , bridges, dams, cannals, Highways etc. Granite of Nagar Parkar because of thinner low porosity and high crushing strength have all Engineering characteristic for use in road construction in accordance with AASHTO, ASTM and BS Standards. Increase in road construction in Thar District and Desert including the surrounding districts, the location and development of qualities which will supply the aggregates to the local Market and will save the cost of long distance. Both petrologic, petrographic methods of studies have also been kept in consideration during engineering properties studies identifying the mineralogy grain size, Texture, Fabric and the weathering states, were kept in consideration also.

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