`

SUITABILITY ASSESSMENT OF SARBAN HILL LIMESTONE AS AN AGGREGATE IN ROAD CONSTRUCTION

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ABSTRACT

This study comprises of geotechnical properties of Sarban Hill Limestone, located in heart of Hazara region, Abbottabad. The study evaluates the geotechnical behavior of Sarban Hill limestone and its validity in road construction. By collecting the samples from crushing plant located near Sarban Hill limestone performed several geotechnical tests in NHA Laboratory Mansehra to determine the geotechnical strength of Sarban Hill Limestone. Geotechnical tests performed include Flakiness and Elongation, Los Angeles Abrasion, Soundness and Crushing value test. To understand the geotechnical strength of Sarban Hill Limestone different laboratory tests were analyzed and compared with pre-existing well-defined standards like American Society for Testing and Materials(ASTM), American Association of State Highways and Transportation Officials (AASHTO), British Standards(BS), National Highway Authority(NHA) and American Concrete Institute(ACI).After detailed analysis and comparison with national and international standards, it is concluded that the studied formation is suitable and therefore an important aggregate resource for road construction.

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CHAPTER 1
INTRODUCTION

1.1 Rocks

A rock is a naturally occurring aggregate of minerals. These natural occurring aggregates constitute the basic unit of which the earth is composed. In solid Earth most of the components consist of the hard laying substances known as rocks.

Rocks are the main building blocks of the hard-solid earth to give it more strength and complex geology.

1.1.1 Applications of rocks

Rocks are used in many engineering projects ranging from firm concrete structures to compacted highways. Rocks are used in these purposes because of their ultimate strength, more compatibility and high stability. The branch of the geology in which we study about the engineering projects, their manufacturing and uses of rocks aggregate in these are known as engineering geology. Geologists are required to understand the behavior of geological materials i.e., rocks and soils and their relationship with engineering structures like construction of roads, buildings, dams and all other projects in which geological materials are used. To start a major or minor project understanding the local geology and its components are important to understand the geology of the region allows suitable location selection for the project.

1.1.2 Application of sedimentary rocks

In road construction, sedimentary rocks are used commonly. As sandstone and limestone are not greatly affected by the ground motion and conditions and therefore are mostly used in road construction practices. Shale aggregate can also be used in road construction. Sedimentary rocks are most reliable for the construction, pavement of road and roadbed.

Figure 1.1 Sedimentary rock aggregate for concrete.

1.1.3 Applications of Igneous rocks

Igneous rocks can be used for the making of tiles which can be directed for the decoration of homes. They are widely used for the manufacturing of sculptures and buildings. Granite is very good choice to be used as building material.

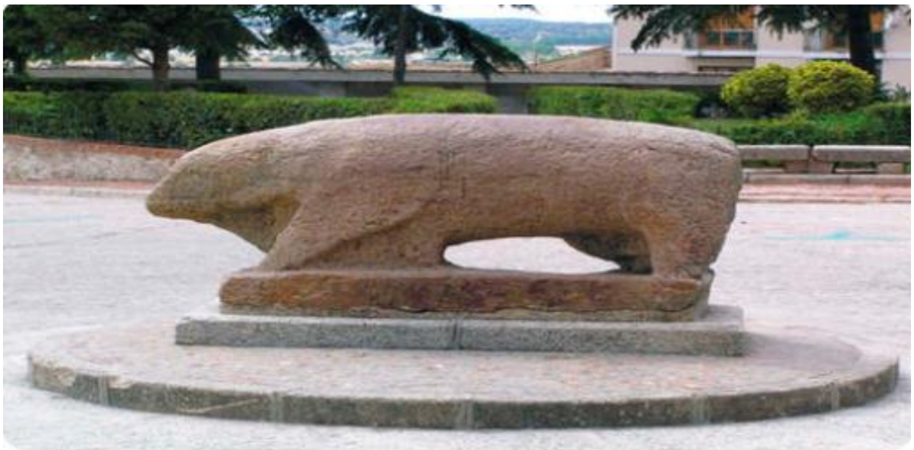

Figure 1.2 Granite (igneous rock) statue.

1.1.4 Application of metamorphic rocks

Metamorphic rocks are widely used as building stone and for making statues. Slate was mostly used for the manufacturing of ceiling tiles and classroom blackboards in the ancient times(Erugene, 2008)

For building materials marble along with quartzite are used. Structures like sculptures are made through marble. Marble is also used in plastic industry. Quartzite is often used in rail ballast to absorb vibrations. Lead that is used in pencil is also found in

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metamorphic rocks.

Figure 1.3 use of metamorphic rock.

1.2 Road construction

A network of roads and highways are the backbone of progress of any country. A country with good civil engineering projects is more considered to be good for trade and travel. Geotechnical research plays an important role in these types of projects.

The purpose of good pavement design is to make the roads safe for traveling for motorist. The goodness of roads and civil structures depends upon the selection of good material for the manufacturing. To judge this issue, a study method was adopted to find the alternatives for pavement materials. There are proper studies or principles, if those where followed a good construction can be done.

When we planning to construct a new road, it should be carefully considered before building, the improper constructed road costs millions of dollars and a life of a human before planning the design of a highway, engineers should determine its need and looking to find a solution to adverse environmental impacts (Brennan, 2002).

Construction of roads involves the paving, rehabilitation, and/or reclamation of degraded pavements in order to achieve a state of good repair and increase road traffic safety. Road construction involves the use of asphalt, liquid asphalt, concrete, soil stabilization, paving and pavement recycling machines, and other road repair materials.

1.3 Aggregate properties

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The important property of engineering aggregates used in pavement of a road are its shape and size; shape and structure; density; hardness and stability. The sterile set frees its individual cells from a stable sequence in the specifications of the standards for the allowable maximum amount of coherent harmful material present in coarse and fine aggregates (Flattery, 2002).

Total intensification and size, i.e., maximum size of particle and mixing size, the strength of a pavement and cost in a composite alloy are affected when the particles should be bound with bituminous binder. The change in size changes the amount and the cost. The cement should develop a mixture of consistency and quality depend on the interlocking of coarse particles and used to describe and integrate particle size and surface texture for giving information about their internal properties characteristics, i.e. (through) Interlocking (meaning of surface friction between adjacent surfaces of particles) total due to very high friction with angularity particle texture. In contrast, smooth round aggregates have less internal friction in the form of particle well interlock and bad surface friction; therefore, gravel may need to be crushed. When holding the surface along bitumen in the dressing of the carriageway and crushed under the roller the outcome result is very poor embedment. The size of a particle has a enhanced effect on the bitumen properties. Hard textured gravels (both coarse and fine) contribute a lot stability of pavement compared to size of aggregates having smooth texture. The capability of a hard aggregate is to prevent the effects of abrasiveness of traffic. When water comes out of the surface it is associated with the vehicle's tires (as well as with the user). The effect of hysteresis on tire-tread rubber to control the kinetic energy depends on a resistance of its component for its continuation. All pavement layers should be covered, which ensures there is a risk to fine material cells produced by circulation is kept at acceptable levels. Hard aggregates are the ones that can prevent cracks for better application (Flattery,2002).

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1.4 General statement

Geotechnical examination in Pakistan isn't having a high estimation of significance. Most financial specialists are not keen on geotechnical examination as a result of setting aside a cash and don't have the foggiest idea about the estimation of geotechnical examination. Be that as it may, in the repercussions of the overwhelming seismic tremor in 2005, geotechnical examinations have gotten progressively significant. Ensuing examinations have indicated that structures (streets) are developed without geotechnical examinations and in result seismic burden can't tolerate. After 2005, government was requested to present a geotechnical examination report before developing a structure. Keeping in view the geotechnical importance of geological materials in any engineering project, in the current study an attempt is made to evaluate the geotechnical considerations of Sarban Hill Limestone.

1.5 Objectives

The current study has following objectives:

i. To find the geotechnical characteristics of Sarban Hill Limestone.

ii. To assess the compatibility of Sarban Hill limestone in road construction practices.

1.6 Location and Accessibility

The study area is shown by a red color mark located between 34° 08' 48.66" N and 73° 12' 52.16" E in the district Abbottabad of Khyber Pakhtunkhwa province. It can be reached easily from main Karakorum Highway from Abbottabad towards Gilgit in about one hour. The samples were collected from the area named as Kunj near Abbottabad city.

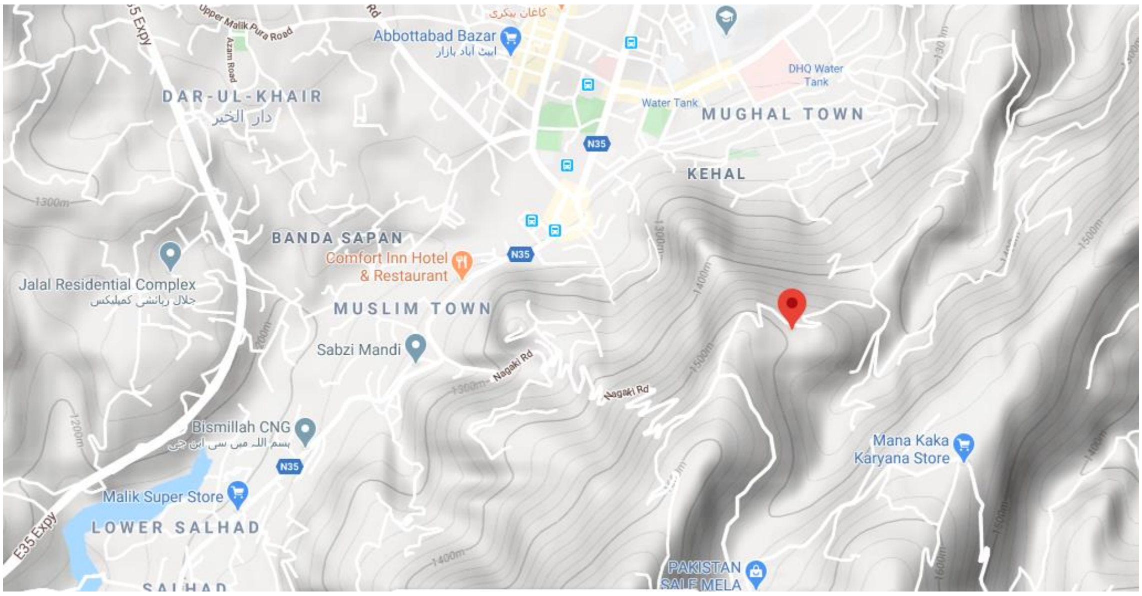

Figure 1.4 Accessibility map of study area (study area is highlighted by a Red mark).

1.7 Methodology

Samples were collected from Sarban Hill Limestone, exposed in Kunj area, Abbottabad. Samples were then transported to NHA lab for geotechnical tests involving Crushing test, Soundness test, Los Angles Abrasion test, Apparent Density test, Gradation Analysis and Flakiness& Elongation test. Geotechnical test results were interpreted and compared with national standards including National Highway Authority (NHA) and international standards involving American Society for Testing and Materials (ASTM), American Association of State Highways and Transportation Officials (AASHTO), British Standards (BS), and American Concrete Institute (ACI).

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CHAPTER 2

STRATIGRAPHY AND TECTONIC OF PAKISTAN

2.1 Tectonic Setting

Geo scientific research during the past two decades has established Pakistan as one of the most fascinating parts of the globe. A collision mountain belt comprising the Himalaya, Karakoram and Hindukush Ranges forms its northern part. Extensive nappes and thrust sheets with Barrovian metamorphism, large granitic batholiths, and sutures marked by melanges, ophiolite and high-P metamorphic rocks characterize these mountain ranges. Some parts of the mountains, rising at. a fast rate of over 5 mm/yr, expose granitic plutons only a few million years old. I~l terms of plate tectonics the opening of the western part of the Indian Ocean and the 4,000 km northward drift of India: and its collision with Asia are unique events. Within a small region one can study a major transform plate boundary (the Chaman Fault), subduction-related suture zones (Indus and Shyok sutures), fossil island arcs (Chagai, Kohistan, Ladakh), and a trench-arc system with active plate subduction and deformed plate margins (Makran). Seismotectonically, a large part of Pakistan is very active and several neotectonic features have been mapped. The exposed rock sequence includes Precambrian metamorphic and plutonic rocks, Paleozoic, Mesozoic and Paleogene pre cratonic shelf deposits which form the platform cover and the marginal fold belt, and an extensive and exceptionally thick· pile of Neogene molasse (Siwaliks) that fills the foredeep. Famous for their rich and exotic vertebrate fauna, the Siwaliks are the product of intense denudation that accompanied the uplift of the Karakoram and the Himalayas, which may have removed half of the elevated crustal mass in these rapidly rising mountains. Part of this debris was deposited on the ancient Siwalik flood plains, but by far the greater amount was carried to the sea to form the second largest submarine fan in the world, the Indus fan. Pakistan has been geologically well-known for several decades for its great mountains, extensive glaciers, devastating earthquakes, exotic and prolific Neogene vertebrate fauna, chromite-bearing ophiolites, Precambrian and Paleozoic succession of the Salt Range, the abundant

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oroclinal flexures and enigmatic syntaxes in its mountain ranges, and the deep gorges and canyons that highlight the antecedent drainage. These geologic features had been largely revealed by the reconnaissance surveys of the early pioneers who explored vast areas despite a lack of proper topographic base maps, inhospitable terrain, hostile tribal conditions and absence of roads and communication system. Geological Survey geologists, based at Calcutta, would travel to Sindh, Balochistan, Punjab, and NWFP on elephants, horses, or on foot (Heron 1953), and on approaching their destination would often find themselves in the midst of skirmishes between the British troops and the local chieftains or the Afghans.(Zeitler, 1996), (Ahmed, 2003)

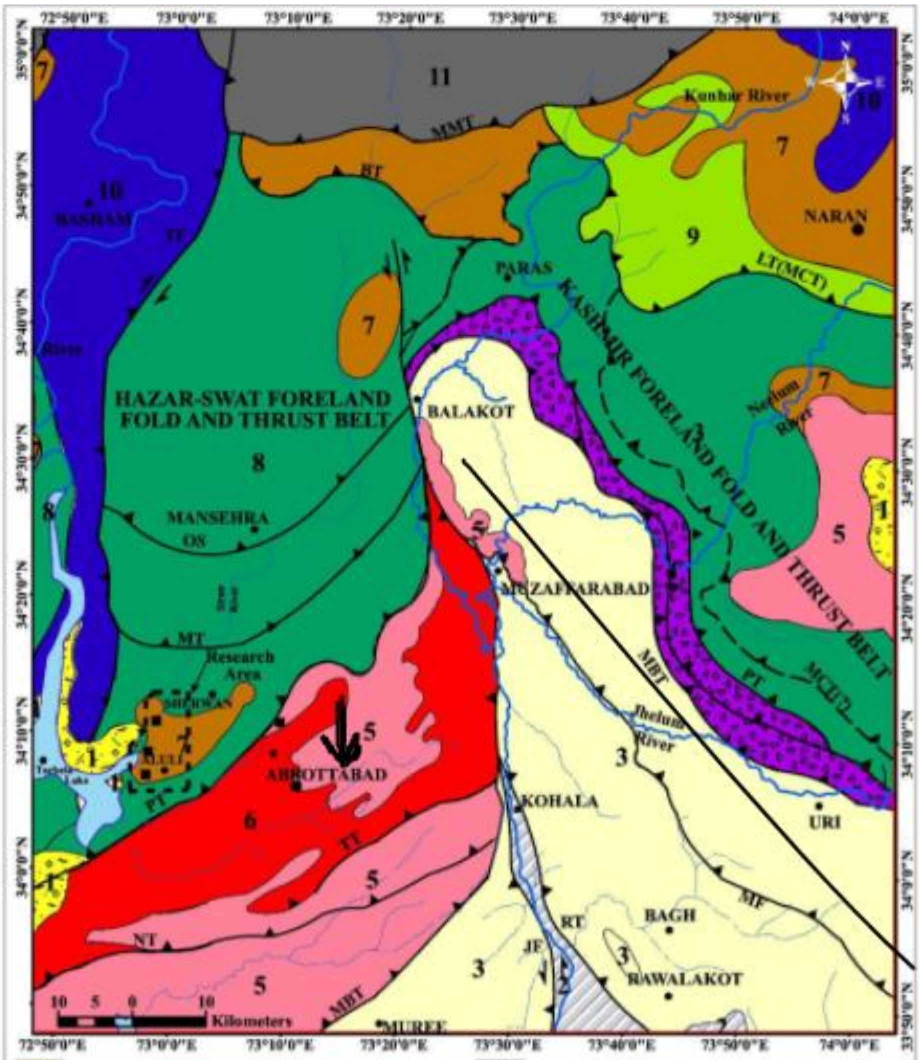

Figure 2.1 Hazara region tectonic maps(Muhammad Qasim 2014)

2.1.1 Karakorum Block

The Karakorum Block records a predominantly marine Ordovician to Cretaceous sedimentary history. Six major sedimentary cycles are recognized. The oldest sediments, Early Ordovician, transgress over a crystalline basement. The 1-km-thick Ordovician-Silurian mostly shaly succession contains rare carbonate intercalations. In the Early Devonian, a wide peritidal platform spread over the craton. Sedimentation rates were low, 10–20 m/Ma, and Upper Devonian-probable Lower Carboniferous carbonates and clastics rest unconformable on the Early Devonian carbonates. No evidence has been found for either Late Carboniferous or

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glaciogenic deposits. Sedimentation rates increased during the Permian up to 50 m/Ma, with thicknesses between 1 and 2.5 km. Three steps are identified. (1) A huge alluvial to marginal-marine erogenous prism aggraded during the Asselian-Sakmarian. (2) The Artinskian-Murgabian is characterized by local emergence and erosion, linked to extension with block rotations. (3) Greater differentiation occurred from Late Permian to Middle Triassic, when a peritidal carbonate flat developed in the southwest, facing a deeper basin to the northeast. Carbonate sediments prevailed throughout the Carnian-Norian. The Permo-Triassic evolution is interpreted as the passive margin stage of the Karakorum Block, which previously belonged to the Perigondwanian fringe, when, like Mega Lhasa, it drifted northward on the Tethyan Transit Plate. Mega Lhasa is considered as a collage of blocks possibly separated by thinned crust or short-lived seas with ocean crust. (Yoshida et al., 1997).

2.1.2 Main Karakorum Thrust

The Main Karakoram Thrust (MKT) structures the southern limitof the Karakoram square. MKT is a significant structural element in North Pakistan. The fundamental Karakoram push starts from the Karakoram Plate towards the Kohistan Island Arch (KIA) (Tahirakeli, 1983).

2.1.3 Kohistan Island Arc

The great bulk of Kohistan represents growth and crustal accretion during the Cretaceous at an intra-oceanic island arc dating from *c.* 134 Ma to *c.* 90 Ma (Early to Late Cretaceous). This period saw the extrusion of *c.* 15–20 km of arc volcanic and related sedimentary rocks as well as the intrusion of the oldest parts of the Kohistan batholith, lower crustal pluton intrusion, crustal melting and the accretion of an ultramafic mantle–lower crust sequence. The crust had thickened sufficiently by *c.* 95 Ma to allow widespread granulite-facies metamorphism to take place within the lower arc. At around 90 Ma Kohistan underwent a *c.* 5 Ma high-intensity deformation caused by the collision with Eurasia. The collision created crustal-scale folds and shears in the ductile zone and large-scale faults and thrusts in the brittle zone. The whole terrane acquired a strong penetrative foliation fabric. Kohistan, now an Andean margin, was extended and intruded by a diapiric-generated crustal-scale mafic–ultramafic intrusion (the Chilas Complex) with a volume of 0.2×10^6 km^3 that

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now occupies much of the mid–lower crust of Kohistan and had a profound impact on its thermal structure.(Ahmad, 2003).

2.1.4 Main Mantle Thrust

The Main Mantle Thrust Zone (MMTZ) represents the boundary between the Indian plate and the Kohistan Ladakh arc in Pakistan and is equivalent to the Indus Suture Zone. It includes discontinuous fault slices of m61ange that lie between the Kohistan arc and the Indian plate. (Patriot, 1984).

2.1.5 Northern Deformed Fold and Thrust Belt

The NDFTB stretches out through the Kurram locale close to Afghan fringe in the west to the Kashmir Basin(Khan, 2011). An assortment of vigorously twisted dregs and metasedimentary and molten rocks. The North Disability Fold and Thrust Belt (NDFTB) is situated in the north by MMT and South by MBT and isolated from the South distort curve Thrust Belt. Fundamental limit push (MBT) and salt range push (SRT) are key individuals from this shortcoming framework (Yates,1987).

2.1.6 Main Boundary Thrust

The Main Boundary Thrust (MBT) is one of the major Himalayan thrusts occurring during the Cainozoic, and it is presently incorporated within the Himalayan thrust wedge (Lesser and Outer Himalayas) displaced above the Indian lithosphere.

The Main Boundary Thrust in northwestern Pakistan is a floor thrust along which a thrust system incorporating Precambrian and Phanerozoic rocks of the Kala ChittaandAttock-Cherat Ranges was emplaced over Cenozoic strata of the northern Kohat and Potwar Plateaus. The MBT and successive thrusts toward the foreland are interpreted as low angle to flat decollement thrusts at 8–10 km depths that bound thrust sheets with large lateral dimensions.(Seeber and Arbaster 1979)

2.1.7 Southern Deformed Fold and Thrust Belt

The Southern Deformed Fold and Thrust Belt (SDFTB) edges the Himalayan mountain belt from the Ganges Delta in India toward the South Waziristan Agency in Pakistan. It is east-west surface. SDFTB is separated into the Kohat Plateau toward the west and the Potwar Plateau toward the east of the Indus River. In the Potwar Plateau,

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there are inalienably low misshappening fold and push belts of around 150 km in the north-south course (Kazmi and Rana, 1982). The Salt Range Thrust (SRT) and the Trans Indus Range Thrust (TIRT) are found south of the SDFTB and are isolated from the Punjab Foredeep. Inability is for the most part confined toward the North Potwar Disability Zone (NPDZ). SRT speak a functioning misshaping front, alongside the Paleocene rocks from the Cambrian toward the south into the Punjab Fordeep (Ahmed, 2003). Kohat Plateau located in the southern turned overlap outrageous west of the Zor Belt (Khan, 2011).

2.1.8 Punjab Fore deep

Punjab is the deep boundary to the south-west of the Himalayan mountain range in the Indo-Pakistan shield and covered by non-concomitant quaternary sediments. The present-day depocenter for detrious and flotsam as long as the Himalayan chain towards south (Ahmed, 2003).

2.2 Tectonics of study area

Tectonically, Abbottabad Block is located in Upper Indus Basin where it is bounded by Main Central Thrust (MCT) in the north, Main Boundary Thrust (MBT) in the southeast and Indus River in the west. Generally , the structures in this area are developed as a result of compression and the entire zone is part of the Lesser Himalayas. Khairabad Fault runs across the Abbottabad Block which trends in northeast-southwest direction (Ahmed, 2003)

34.1688° N, 73.2215° E.

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2.3 Stratigraphy of study area

Stratigraphy of this region ranges from InfraCambrian to Mio-Pliocene. The block mostly consists of Precambrian to Eocene strata. Cambrian age granite and metamorphic rocks constitute the northern part whereas Permian to Eocene sedimentary sequence is present in the southern portion of this block area.Abbottabad Block, covers an area of 2298.67 sq km and is located in Abbottabad, Haripur and Mansehra districts of Khyber Pukhton Khwa (KPK) Pakistan. The block is located about 120 kilometers north of Islamabad through Karakoram Highway and 152 kilometers east of Peshawar. Geologically, it lies in the Peshawar Basin of Pakistan. The block falls in Prospectivity Zone I. (Muhammad qasim 2014)

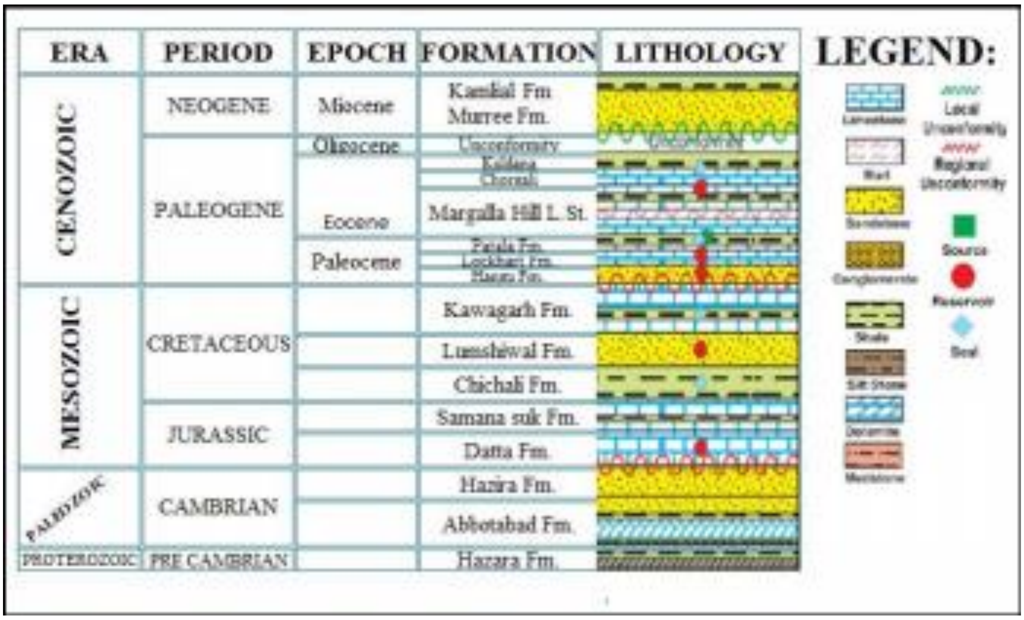

Figure 2.2 Generalized stratigraphy chart of Sarban Hill Limestone.(Muhammad Qasim 2014)

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CHAPTER 3
STANDARDS AND PROCEDURE

3.1 Gradation test for fine and coarse aggregate (AASHTO-T27)

3.1.1 Introduction

This method is used to find the distribution of particle size of aggregate. Test results assists in assessing the suitability of aggregate quality as an aggregate to be used in road construction practices.

3.1.2 Definition

The sieve analysis is conducted to determine the grading of materials proposed for use as aggregates or being used as aggregates.

3.1.3 Apparatus

- **i.** Sieve set (9.5mm, 4.75mm, 2.36mm, 1.18mm)
- **ii.** Mechanical sieve shaker
- **iii.** Weighing Balance
- **iv.** Brush
- **v.** Oven

Figure 3.1 Sieves of different sizes.

3.1.4 Procedure

Prepare a sample of 3000g or more, put it in oven at (110℃) and dry it to constant mass. Select sieves with suitable openings to furnish the information required by the

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specifications covering the material to be tested. Use additional sieves as desired or necessary to provide other information, such as fineness modulus, or to regulate the amount of material on a sieve. Nest the sieve in descending order from top to bottom and place 1000g sample on the top sieve. ¬Determine the empty weight for each sieve and record in a table. Agitate (shake) the sieve by hand or by mechanical shaker for a sufficient period (10min.). (Prevent an overload of material on an individual sieve by splitting the sample into two or more portions, sieving each portion individually. Combine the masses of the several portions retained on a specific sieve before calculating the percentage of the sample on the sieve.) Weigh each sieve with the residue record its weight. ¬Open the set of sieves carefully so that no loosing of materials is expected. Make sure that the summation of the residue weights equals to the original sample weight with a difference not more than 1% of the original weight tabulate your data in a suitable shape.

3.1.5 Formula

The formulas used in the procedure are:

Mass Percentage passed No.200 sieve= [(The total sample weight before washing-sample weight after washing)/The total sample weight before washing] *100.00

Percentage of retain-weight = (Weight retained/ Total weight of the sample) *100

Cumulative retain-weight -percentage = firstly retain-weight / secondly retain-weight

Percentage of passing= 100-Commulative retain-mass percentage

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Figure 3.2 Gradation by sieve.

3.2 Soundness test for aggregate (AASHTO-T12)

3.2.1 Introduction

This test is used to determine the resistance of aggregates to disintegrate by saturated solutions of sodium sulphate or magnesium sulphate.

This test is easy but time taking.

3.2.2 Definition

The ability of material to resist in response of the standard chemicals solutions which are Na_2SO_4, $MgSO_4$, $BaCl_2$ in 5-cycles absorption period.

3.2.3 Objective

To determine the weathering action of aggregates.

3.2.4 Apparatus

I. Sample container
II. Weighing machine
III. Drying oven
IV. Immersion tank
V. Temperature regulations
VI. Specific gravity measurement
VII. Chemicals ($BaCl_2$, Na_2SO_4, $MgSO_4$)

3.2.5 Procedure

Take individual samples in a wire mesh basket and immerse it in the solution of sodium sulphate or magnesium sulphate for not less than 16 hours not more than 18 hours, in such a manner that the solution covers them to a depth of at least 15 mm. After completion of the immersion period, remove the samples from solution and allow it to drain for 15 minutes and place it in drying oven. Dry the sample until it attains a constant mass and then remove it from oven and cool it to room temperature. After cooling again immerse it in the solution as described in step-1. The process of alternate immersion and drying is repeated until the specified number of cycles as agreed between the purchaser and the vendor is obtained. After completion of the final cycle and after the sample has been cooled, wash it to free from sodium sulphate or magnesium sulphate solution. This may be determined when there is no reaction of the wash water with barium chloride. Then dry each fraction of the sample to constant temp of 105 to 110^0C and weigh it. Sieve the fine aggregates over the same sieve on which it was retained before test. Sieve the coarse aggregate over the sieve shown below for the appropriate size of particles.

Figure 3.3 Chemicals used in method.

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3.2.6 Report

The result should be reported giving the following particulars

- Type of solution used for the test
- Weight of each fraction of sample before the test.
- Material from each fraction of the sample passing through the specified IS sieve, expressed as a percentage by weight of the fraction.
- In the case of particles coarser than 20 mm size before the test, the number of particles in each fraction before the test and the number of particles affected classified as to the number disintegrating, splitting, crumbling, cracking, flaking etc.

3.2.7 Formula

Soundness aggregate= (Initial Mas-Retain Mas)/ (Initial Mas*100)

3.3 Flakiness and Elongation test (ASTMD4791)

3.3.1 Introduction

Flaky and elongated aggregates can adversely affect concrete. Flaky and elongated aggregates are difficult to compact. Therefore, using flaky and elongated aggregates will reduce concrete workability, which required more amount of water to produce a workable mix. Increasing water content will reduce concrete strength and durability. Moreover, these aggregates are not robust, which leads to lowering concrete strength.

3.3.2 Definition

- The Flakiness Index of aggregates is the percentage by weight of particles whose least dimension (thickness) is less than three- fifths (0.6times) of their mean dimension. This test does not apply to sizes smaller than 6.3mm.
- The Elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than nine-fifths (1.8times) their mean dimension. Flakiness and elongation tests are not applicable to sizes smaller than 6.3mm

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3.3.3 Procedure

Size of thickness aggregate		**Thickness gauge (nm)**	**Length gauge(mm)**
Passing through is sieve	**Retained on is sieve**		
63	50	33.90	-
50	40	27.00	81.00
40	25	19.50	58.5
31.5	25	27.95	-
25	20	13.50	40.5
20	16	10.80	32.4

Table 3.1 No of sieves.

A quantity of aggregate shall be taken sufficient to provide the minimum number of 200 pieces of any fraction to be tested. The sample shall be sieved with the sieves specified in Table 1:

.

Separation of Flaky material- Each fraction shall be gauged in turn for thickness on a metal gauge of the pattern shown in Figure 2, or in bulk on sieves having elongated slots. The width of the slot used in the gauge or sieve shall be of the dimensions specified in column 3 of Table 1 for the appropriate size of the material. The total amount passing the gauge shall be weighed to an accuracy of at least 0.1 percent of the weight of the test sample. The Flakiness Index is the total weight of the material passing the various thickness gauges or sieves, expressed as a percentage of the total weight of the sample gauged. Separation of Elongated Material- Each fraction shall be gauged individually for length on a metal length gauge of the pattern shown in Figure 4. The gauge length used shall be that specified in column 4 of Table 1 for the appropriate size of the material. The total amount retained by the length gauge shall be weighed to an accuracy of at least 0.1 percent of the weight of the test sample. The elongation index is the total weight of the material retained on the various length gauges, expressed as a percentage of the total weight of the sample gauged.

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3.3.4 Calculation

1. The Flakiness Index on an aggregate is = Total weight passing Flakiness Gauge x 100 / Total weight of test sample =_________(%)
2. The Elongation Index on an aggregate is = Total weight retained on Elongation Gauge x 100 / Total weight of test sample =________(%)

3.4 Los Angeles Abrasion test of aggregate (AASHTO-T96)

3.4.1 Introduction

The Los Angeles test is a measure of degradation of mineral aggregates of standard gradings resulting from a combination of actions including abrasion or attrition, impact, and grinding in a rotating steel drum containing a specified number of steel spheres. The Los Angeles (L.A.) abrasion test is a common test method used to indicate aggregate toughness and abrasion characteristics. Aggregate abrasion characteristics are important because the constituent aggregate in HMA must resist crushing, degradation and disintegration in order to produce a high quality HMA.

3.4.2 Definition

The abrasion loss mass percentage is measured to the whole mass of materials under defined conditions such as revolution and mass of ball.

3.4.3 Apparatus

i. Spherical Balls
ii. Machine (The machine is equipped with a counter. The machine shall consist of hollow steel cylinder closed at both ends. An opening in cylinder shall be provided for introducing the sample
iii. Sieves
iv. Aggregate used in highway pavement should be hard and must resist wear due to the loading from compaction equipment, the polishing effect of traffic and the internal abrasion effect.
v. The road aggregate should be hard enough to resist the abrasion of aggregate. Resistance to abrasion is determined in laboratory by loss angles abrasion test.

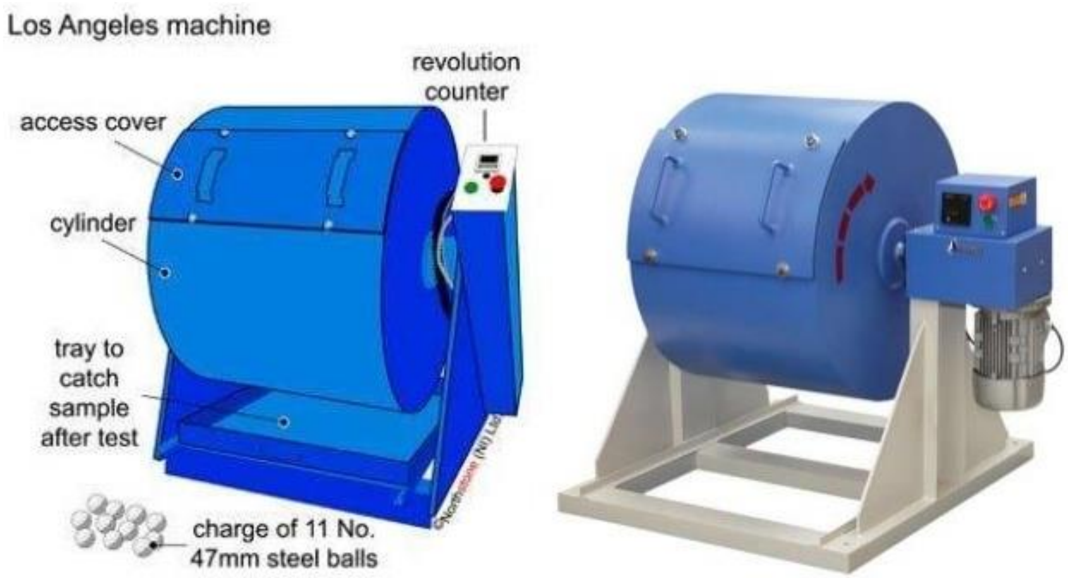

Figure 3.4 setup for Los Angeles abrasion test.

Table 3.2 Grading classes.

Grading	**Charges**
‘A’	12.00
‘B’	11.00
‘C’	8.00
‘D’	6.00

3.4.4 Procedure

Prepared sample is placed in the abrasion-testing machine. A specified number of steel spheres are then placed in the machine and the drum is rotated for 500 revolutions at a speed of 30 - 33 revolutions per minute (RPM).The material is then separated into material passing the 1.70 mm (No. 12) sieve and material retained on the 1.70 mm (No. 12) sieve. Dry the sample in an oven. Calculate %age loss due to Abrasion by calculating the difference between the retained material (larger particles) compared to the original sample weight. The difference in weight is reported as a percent of the original weight and called the "percent loss".

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3.4.5 Formula

Mass of loss = Initial Mass - Final Mass of retain coarse fractions (sieve.12)

Percentage of Loss (L.A) = (Weight of loss / Initial weight) *100

3.5 Crushing test of aggregate (BS-812)

3.5.1 Introduction

Coarse aggregate crushing value is the percentage by weight of the crushed material obtained when test aggregates are subjected to a specified load under standardized conditions. Aggregate crushing value is a numerical index of the strength of the aggregate and it is used in construction of roads and pavements. Crushing value of aggregates indicates its strength. Lower crushing value is recommended for roads and pavements as it indicates a lower crushed fraction under load and would give a longer service life and a more economical performance. The aggregates used in roads and pavement construction must be strong enough to withstand crushing under roller and traffic. If the aggregate crushing value is 30 or higher' the result may be anomalous and in such cases the ten percent fines value should be determined instead.

3.5.2 Definition

Aggregate crushing value test on coarse aggregates gives a relative measure of the resistance of an aggregate crushing under gradually applied compressive load.

3.5.3 Apparatus

i. steel cylinder 15 cm diameter with plunger and base plate.
ii. A straight metal tamping rod 16mm diameter and 45 to 60cm long rounded at one end.
iii. A balance of capacity 3 kg readable and accurate to one gram.
iv. IS sieves of sizes 12.5mm, 10mm and 2.36mm
v. A compression testing machine.
vi. Cylindrical metal measure of sufficient rigidity to retain its from under rough usage and of 11.5cm diameter and 18cm height.
vii. Dial gauge

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3.5.4 Procedure

Put the cylinder in position on the base plate and weigh it **(W)**. Put the sample in 3 layers, each layer being subjected to 25 strokes using the tamping rod. Care being taken in the case of weak materials not to break the particles and weigh it **(W1)**. Level the surface of aggregate carefully and insert the plunger so that it rests horizontally on the surface. Care being taken to ensure that the plunger does not jam in the cylinder. Place the cylinder with plunger on the loading platform of the compression testing machine. Apply load at a uniform rate so that a total load of 40T is applied in 10 minutes. Release the load and remove the material from the cylinder. Sieve the material with 2.36mm IS sieve, care being taken to avoid loss of fines. Weigh the fraction passing through the IS sieve **(W2)**.

Figure 3.5 Method of performing compression test for stone.

3.5.5 Formula

The ratio of weight of fines formed to the weight of total sample in each test shall be expressed as a percentage, the result being recorded to the first decimal place.

Aggregate crushing value = (W2 x 100) / (W1-W)

`

W2 =Weight of fraction passing through the appropriate sieve

W1-W =Weight of surface dry sample.

The mean of two result to nearest whole number is the aggregate crushing value.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Gradation test for fine and coarse aggregates (AASHTO-T27)

4.1.1 Calculation

Percentage of Weight Passing (Sieve.200) = [Before washing sample weight – After washing sample weight) / before washing sample weight] ×100.00 Percentage of Weight retains = (Weight of retains / Total weight of sample) × 100.00 Percentage of weight of Cumulative retain = Weight of retains first +Weight of retain second

Passing % = 100– Cumulative weight percentage.

4.1.2 Results

Table 4.1. Gradation test results.

Weight of grading sample(g)	Sieve size(mm)	31.5		26.5		19		16		9.5		4.75		2.36	
	Weight of after gading (g)	0	0	353	393	910	971	2117	2101	1121	1304	602	600	62	66
	% Retained	0.0	0.0	6.8	7.2	17.6	17.8	40.8	38.5	21.6	23.9	11.6	11.0	1.2	1.2
5185	% retain total	0.0		7.0		24.7		64.3		87.1		98.4		99.6	
5453	% passing	100.0		93.0		75.3		35.7		12.9		1.6		0.4	
	Total weight= 10607 No.4 Passing Sieve = 2771g, Sample for fine material = 1166.7g														

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4.1.3 Description

Gradation test is used for the various size distributions of aggregates (Table 4.1) in order to make road we used as a source of different materials in which there is different layers and various materials are used in each layer. The size of a material which is use in gradation testing if passing through #4 sieve is fall in a category of fine aggregate material and if it retained above #4 sieve it is fall in a category of coarser aggregate material.

4.2 Soundness test of aggregate

4.2.1Calculations

Soundness of aggregate = [(Initial weight of sample-Retained weight of sample)/initial weight of sample] ×100.00

4.2.2 Results

Table 4.2 Soundness test results

Sieve size (mm)	Mass of sample before test(g)	Mass of sample after the test(g)	Percent soft particle%
4.75-9.5	372.5	364.8	2.1
9.5-16	617.1	606.7	1.7
16-19	1010.4	996.2	1.4
AGGREGATE SOUNDNESS TEST			
Sieve size(mm)	**weight of drying sample before test(g)**	**weight of drying sample after test(g)**	**loss in mass%**
2.36-4.75	500	459.5	8.0
4.75-9	500	472.9	5.4
9.5-19	1000	957.8	4.2
			17.6

4.2.3 Description

According to Britain standard (BS-882) soundness value of aggregate must be less than 30% and the value obtained from the soundness test of Sarban Hill Limestone is 17.6% (Table 4.2). This shows that the soundness property of

`

Sarban Hill Limestone is suitable for the use in road layers.

Table 4.3Result comparison with standard

Codes Standards	**Standard value**	**Result obtained**
BS-882	<30%	17.6

4.3 Flakiness and elongation test (ASTMD4791)

4.3.1 Calculation

The Flakiness Index on an aggregate is = Total weight passing Flakiness Gaugex 100 / Total weight of test sample. The Elongation Index on an aggregate is = Total weight retained on Elongation Gauge x 100 / Total weight of test sample.

4.3.2 Results

Table 4.4 flaky and elongated results.

% FLAKY ELONGATED MATERIAL.	**SIZE(MM)**	4.75-9.5	9.5-16	16-19	18-26.5	26.5-31.5	31.5-37.5	**TOTAL**
WEIGHT OF SAMPLE(g)	**Wt of sample after grading for each size (g)**	838.0	300.0	100.0	2000.0	3000	/	7138.0
	Wt of sample flanky/elongated for each size (g)	80	96	110	120	105	/	511
	Percent % total	**7.2**						

`

4.3.3 Description

The particle shape of aggregates is determined by the percentages of flaky and elongated particles contained in it. So, the test results meet the standard and they are suitable for use. The results obtained by sample test are mentioned above in a table 4.4which justifies the standards and suitable for using in road layers as an aggregate.

4.4 Los Angeles Abrasion test (AASHTO-T96)

4.4.1 Calculations

Mass which is loss = [(Weight of initial of sample – Weight of retains coarser fractions (sieve.12)) *percentage of loss](L.A) =

(Weight of loss sample / weight of initial sample) *100.00

4.4.2 Results

Table 4.5 Los Angeles abrasion test results

<table>
<tr><th>Test times</th><th colspan="2">Aggregate base course (g)</th><th>Sample mass (g)</th><th>After 500 turn grading sample in 1.77 sieve mm (g)</th><th>Results</th><th>Average results</th></tr>
<tr><td rowspan="2">1</td><td>9.5-16mm</td><td>2500.0</td><td rowspan="2">5000.0</td><td rowspan="2">3672.4</td><td rowspan="2">26.6</td><td rowspan="4">26.6</td></tr>
<tr><td>4.75-9mm</td><td>2500.0</td></tr>
<tr><td rowspan="2">2</td><td>9.5-16mm</td><td>2500.0</td><td rowspan="2">5000.0</td><td rowspan="2">3673.7</td><td rowspan="2">26.5</td></tr>
<tr><td>4.75-9mm</td><td>2500.0</td></tr>
</table>

4.4.3 Description

According to National Highway Authority (NHA) standard, the Los Angeles Abrasion value (LAA) for Subbase and base course must be less than 50% and less than 40% respectively. Similarly mention other standard values and then mention that according to all standards the results of LAA for studied formation lies within limit and therefore it is suitable in road construction activity according to LAA.

Table 4.6 Results comparison with standard

Standard codes	**Standard values**	**Result obtained**
NHA-Item201,1998	Subbase< 50% Aggregate base coarse <40%c Asphaltic base coarse <40%	26.6%
AASHTO-M147	Subbase< 50% Aggregate base coarse <50%c Asphaltic base coarse <50%	26.6%
ASTM-D1241	Subbase< 50%	26.6%
	Aggregate base coarse <50%c Asphaltic base coarse <50%	
BS-812	Aggregate base coarse <45%	26.6%

4.5 Crushing test of aggregate (BS-812)

4.5.1 Calculations

The ratio of weight of fines formed to the weight of total sample in each test shall be expressed as a percentage, the result being recorded to the first decimal place. Aggregate crushing value = (W2 x 100) / (W1-W**)** W2 **=**Weight of fraction passing through the appropriate sieveW1-W =Weight of surface dry sample. The mean of two results to nearest whole number is the aggregate crushing value.

4.5.2 Results

Table 4.7 Compression test results

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Sample No	Sample distribution on or not	Sample size cm			Sample area (cm2)	Damaging load (KN)	compression of strength%	Average %
		Length	width	Tallness				
1	Not	5.02	5.0	5.20	25.1	35.22	14.0	**29.0**
2	Not	4.90	4.80	5.00	23.5	134.13	57.0	
3	Not	5.00	4.80	5.10	24.0	38.29	16.0	

4.5.3 Description

Aggregate crushing value test is important to determine the maximum load that can be applied in aggregates to be used in road construction practices. Test result of aggregate crushing values of Sarban Hill Limestone is 29% and according to BS-2001 the value must lay less than 30% and therefore the studies formation meets the standard. (Table 4.8)

Table 4.8 Result comparison with standards

Standard code	Standard value	Result obtained
BS-2001	<30% for base coarse and asphaltic coarse	29.0%

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CONCLUSION

Geotechnical properties of Sarban Hill Limestone are evaluated by performing various laboratory tests. Gradation analysis shows percentages of 98.4 % and 1.6% for coarse and fine aggregates respectively. Soundness test, Flakiness & Elongation test, Los Angeles Abrasion test and Compression test shows the average values of 17.6%, 7.2%, 26.6% and 29 % respectively.

Comparison of obtained laboratory test results with the pre-defined Standards (BS, ASTM, AASHTO, NHA) reveals that Sarban Hill Limestone meets all the specifications and therefore is a valuable aggregate resource to be used in road construction activities.

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REFERENCES

- Posted in Foundation Engineering, G., Posted in Case study, E., Posted in Construction Project, H., Guide, P., Posted in How To Guide, R., Posted in Exclusive, G., . . . Posted in Building Technology Guide, C. (2020, September 25). The Construction Encyclopedia. Retrieved September 29, 2020, from https://theconstructor.org/
- Colm, A.O., 2002. Highways the location design construction and maintenance of road pavement vol 4, 145-147p.
- Hamakareem. I., 2016. Uses of sedimentary rocks in road construction and civil engineering, The constructor civil engineering home, PP 4.
- Kazmi, A.H., and Jan.M.Q., 1997. Geology and Tectonics of Pakistan.Graphic Publishers Karachi – Pakistan 1-554.
- Kian, Teck, et al., 2005. The development of road construction material selection system, Journal of the eastern asia society for transportation studies, Vol.6 , PP 1313-1328..
- Satya et al., 2006. Importance of geology in construction and prevent the hazards, Journal for advances in applied science research, Vol.6, Pg 75-80.
- Siddiqui, K.H., 2009. Material in Construction of Highways and Buildings, New Edition, Ferozsons (Pvt.) Limited, p 9.
- V.R Gannapathy et al., 2008. Risk factors in road construction site, Journal for world academy of science, Engineering and technology, PP46.
- Yeats RS, Hussain A (1987). Timing of structural events in the Himalayan foot hills of NW Pakistan, Geol Soc Am Bull, PP 161–176.

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