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APPROVAL PAGE

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DEPARTMENT OF CIVIL ENGINEERING

The undersigned certify that they have read and recommended to the Institute of Engineering for acceptance, the final report of thesis entitle **"A Study on suitability of aggregates of Kavre and Sindhuli district quarries used in Kathmandu valley for different layers of Flexible Pavement "** submitted by Padam Bahadur Madai in partial fulfillment of the requirements for the degree of Master of Science in Transportation Engineering, Nepal is a record of works carried out by him under my supervision and guidance.

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ABSTRACT

This research work focuses on the measurement of quality and usability of road construction materials near the quarries of Kathmandu Valley (Kavre and Sindhuli Districts).To achieve the objectives, four local sources of Kavre & Sindhuli district are chosen from where large amount of materials can be transported to Kathmandu valley for road construction. The quarries chosen are Chalaal Ganeshsthan (Bethanthok – 4, Kavre), Bhyakur Khola at Kalo dhunga (Roshi – 11, Kavre), Ghyampe Khola at Aapghari (Sunkoshi – 01, Sindhuli) and Om Buddha crusher at Kamere (Sunkoshi – 02, Sindhuli) .

This study is mainly focused on the testing of quality of the aggregate as per Standard Specification of Road and Bridge Works (SSRBW), 2073 of department of roads for the construction of different layers of flexible pavement. This study may be useful for finding the nearby location of proper source of material required for road construction during the contract process of any project which reduces the time for finding out the material resources.

For testing of aggregates, samples are collected from every sources of each type of materials which are produced on the nearby crusher. Collected samples are tested on the central laboratory of department of roads, Lalitpur. Relevant IS codes are adopted to conduct the various laboratory tests of the materials required, complying to the Standard Specifications for Road and Bridge Works, 2073of Department of Roads.

As per the laboratory test result of physical properties, it is found that all the processed materials for every pavement component from each source are well graded. Compaction and mechanical strength of sub base from each source are good as maximum dry density is greater than 2.15g/cc and California bearing ratio is more than 60%. Also for base material of all sources, maximum dry density are more than 2.2g/cc , Los Angeles Abrasion (LAA) values are less than 40 %, Aggregate Impact value (AIV) are less than 30% , combined Flakiness & Elongation Index are less than 35 % & crushing ration (CR) more than 80%. , all sources material are suitable for base course. Similarly for Bituminous Macadam (open graded) of all sources, LAA is less than 40%, AIV is less than 30%, combined EI & FI is less than 35%, water absorption value is less than 2% & stripping value is more than 95 %, all sources material are suitable for bituminous macadam. Similarly for Dense Bituminous

Macadam (DBM) of all sources, LAA is less than 35%, AIV is less than 27% except Bhyakur khola (27.38%), combined EI & FI is less than 35%, water absorption value is less than 2% & stripping value is more than 95 %, all sources except Bhyakur Khola material are suitable for bituminous macadam. Similarly for Asphalt concrete (AC) of all sources, LAA is less than 30%, AIV is less than 24% except Bhyakur khola (27.38%), combined EI & FI is less than 35%, water absorption value is less than 2% & stripping value is more than 95 %, all sources except Bhyakur Khola material are suitable for Asphalt concrete.

Keywords: Aggregate, Quarry, Flexible Pavement, Aggregate Test

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LIST OF ABBREVIATIONS

LRN	Local Road Network
SRN	Strategic Road Network
MoPIT	Ministry of Physical Infrastructure and Transport
DoR	Department of Road
DoLIDAR	Department of Local Infrastructure Development and Agricultural Roads
SSRBW	Standard Specification for Road and Bridge Work
AIV	Aggregate Impact Value Test
LL	Liquid Limit
PI	Plasticity Index
CBR	California Bearing Ratio
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
FI/EI	Flakiness Index/ Elongation Index
LAA	Loss Angeles Abrasion Value
SSS	Sodium Sulphate Soundness

CHAPTER 1 INTRODUCTION

1.1 Background

Transportation contributes to the economic, industrial and cultural development of a country. It is considered as the backbone for the development of the nation. So every commodity needs transport facilities for both at the production stage as well as distribution stage. The nature of transport demand depends upon the stage of economic and social development, geographic, topographical and demographic conditions of the country(Gupta & Gupta, 2005).

Since our country Nepal is a landlocked under-developing country, water transport is almost impossible and air transport is very costly. Thus road transport is the major means of transportation for our country. Road Network in Nepal consists of the Strategic Road Network (SRN) and the Local Road Network (LRN). SRN lies under the Ministry of Physical Infrastructure and Transport (MoPIT) and its Department of Roads (DoR) and LRN lies under the Ministry of Federal Affairs and General Administration and its department of Local Infrastructure Development and Agricultural Roads (DoLIDAR) while the responsibility for the daily management lies with the local bodies (DCCs, Rural Municipalities and Municipalities). There is altogether 6823.43km bituminous road, 2044.22km gravel road, 4030.55km earthen roads (SRN) according to 2015/16 report of DoR. Likewise there is altogether 2,004 km bituminous road, 12,823 km gravel road & 42805km earthen roads (LRN) according to 2016 report of DoLIDAR (DoLIDAR, 2016).

Basically in Nepal, flexible road pavements are constructed. The basic components of flexible pavement are Sub grade, Sub-base course, Base course and Wearing course. Sub-grades are prepared either by cutting, filling, leveling and compacting the existing soil surface to 95% of Maximum Dry Density (MDD) or depositing soils from the approved borrow pits to the existing surface up to the designed formation level and compaction. In case of sub-base course, specified graded granular river bed materials or granular materials of quarry sites or borrow pits are generally used. In base course, specified graded crushed stone materials with crushing ratio greater than 80% are used. For surface course, Surface dressing, bituminous macadam, dense bituminous macadam, Asphalt concrete is generally used in our country. In

Bituminous macadam, dense bituminous macadam, Asphalt concrete (for surface course) of specified graded crushed stone aggregates are used as per standard specification for road and bridge work.

The use of inferior construction materials and poor construction process deteriorates the pavement very fast. So, the use of good quality of materials is very essential for effective functioning of pavement throughout its life. The use of locally available good quality construction materials as per specification is very economical to the road construction project. Therefore, it necessary to assess the properties of locally available pavement construction materials to ensure quality of materials that comply the Standard Specifications for Road and Bridge Works, 2073.

1.2 Construction Materials

A pavement may be defined as relatively stable layer or crust constructed over the natural soil. The main function of pavement is to support and distribute the heavy wheel loads of vehicles over a wide area of the underlying sub-grade soil and permitting the deformations within elastic or allowable range and to provide an adequate surface(Gupta & Gupta, 2005). The effective and durable pavement surface is acquired through selection of suitable road construction materials.

1.2.1 Groups of Road Construction Materials

Mineral Materials

Mineral materials such as sub-grade soil, sand/stone dust (fine aggregate), stone chips, gravel/crushed aggregates (coarse aggregates), pit-run sand or river sand, screened materials, blast furnace slag, brick pebbles. These are either naturally occurring, semi processed or fully processed. Stone aggregates are used in pavement construction and road side construction.

Binding Materials

Binding materials includes stone dust or cohesive soil; cement, lime and other inorganic binding materials and; bitumen, tar and other organic binding materials.

Other Materials:

Other common road construction materials such as reinforcement, timber, stones, bricks, boulders, cobbles, gabion wires, geo-textiles, geo-grids, chemical additives, HDP pipes, Hume pipes, precast units etc.

Mineral aggregates make up 90 to 95% of a HMA mix by weight or approximately 75 to 85% by volume. Their physical characteristics are responsible for providing a strong aggregate structure to resist deformation due to repeated load applications. Aggregate mineralogical and chemical makeup are important in evaluating characteristics such as hardness (toughness), soundness (durability), shape, and stripping potential (Fwa, 2006).

In ASTM D8 aggregate is defined as "a granular material of mineral composition such as sand, gravel, shell, slag, or crushed stone, used with cementing medium to form mortars or concrete or alone as in base courses, railroad ballasts, etc."

1.3 Importance of Road Aggregates in the Context of Nepal

Since Nepal has large geological variation, the materials found inside the country will be beneficial for the construction of road. This will finally results the utilization of locally produced materials and enhances the constructions works. Generally flexible pavements are in practice in our country but nowadays rigid pavements are also in practice. In this research work, we have done study about the properties of materials used in different layers of the flexible pavements including different bituminous pavement surfaces.

1.4 Flexible Pavement

Flexible pavements are constructed of bituminous and granular materials. Flexible pavement are those, which on the whole have low or negligible flexural strength and rather flexible in their structural action under the loads. The flexible pavement layers reflect the deformation of the lower layers on-to the surface of the layer. Thus if the lower layer of the pavement or soil sub-grade is undulated, the flexible pavement surface also gets undulated. The flexible pavement layers transmit the vertical or compressive stresses to the lower layers by grain to grain transfer through the points of contact in the granular structure. A well compacted granular structure consisting of strong graded aggregates (interlocked aggregates structure with or without binder materials) can transfer the compressive stresses through a wider area and thus forms a good flexible pavement layer(Khanna & Justo, 1998).

1.4.1 Structure of Flexible Pavement

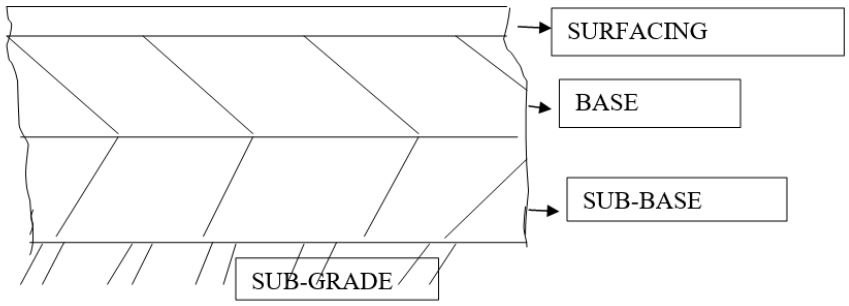

Figure 1-1 Different layers of flexible pavement

The Sub Grade

The entire load of the pavement including the load of traffic transmitted though the pavement is ultimately taken up by the sub-grade. It is also worth mentioning here that by the time the impact of the surface load reaches the sub-grade, the load has spread over a considerably large area and hence the strength requirement of the strata in bearing are much less than that of the upper strata i.e. sub-base, base and wearing courses. A slight improvement in the bearing capacity of soil brought about by proper compaction, stabilization and drainage or combination thereof could be very effective in reducing the thickness of the pavement thereby reducing the initial cost of construction of the road as well as the cost of maintenance (Vazirani & Chandola, 1998).

Sub Base Course

The sub-base also called as road-base is the main structural layer whose main function is to withstand the applied wheel stresses and strains incident on it and distribute them in such a manner that the materials beneath it do not become overloaded (Rogers, 2003)**.**

Base Course

Base course is the foundation layer, designed for its structural stability. The main function of the base course in flexible pavements is to improve the load supporting capacity by distributing the load through a finite thickness. The minimum thickness of base course should not be less than 10cms.

Surface / Wearing Course

It is the component of pavement with which the wheels of vehicles are in actual contact. The main purpose of surface course is to provide smooth and dense riding surface that resists the pressure exerted by wheels of vehicles. The surfacing combines good riding quality with adequate skidding resistance, while also minimizing the probability of water infiltrating the pavement with consequent surface cracks. Texture and durability are vital requirements of a good pavement surface as are surface regularity and flexibility (Rogers, 2003).

1.5 Problem Identification

Kathmandu Valley is Centre for construction activities. Ample amount of construction material is required for different construction purposes .Undergoing construction activities in road around and in Kathmandu Valley demands higher amount of road aggregates with varying standard properties. Thus proper source identification for the road construction is proposed by the study which will reduce the cost of transportation and aid for the good construction materials nearby the site. Also during the contract process of any project, we may refer this study to find the proper source nearby the project which reduces the time for finding out the material resources.

1.6 Site Selection

In this study different quarries of **Sindhuli** and **Kavre** district are chosen. Most of the aggregates for the construction purpose in the Kathmandu valley and around the valleys are brought from these sites as well. The quarries proposed for the study are:

1.6.1 Chalaal Ganeshthan Quarry (Bethanthok -04, Kavre)

This quarry is located in Bethanthok Rural municipality – 04 of Kavre district. It is about 14 km from Banepa & 36 km from Koteswar, Kathmandu.

1.6.2 Bhyakur Khola at Kalo dhunga , Mangaltar

This quarry is located in Roshi Rural municipality - 11 of Kavre district. It is located near the BP Highway and meeting point of Bhyakur khola with Roshi River at Mangaltar, Kalodhunga. It is about 40 km from Banepa. The source of material is deposit of Bhyakur Khola. After every rainy season, materials (Stone, gravel, sand

etc.) are deposited at this area and collected these materials & crushed in crusher plant.

1.6.3 Ghyampe Khola (Aapghari)

This quarry is located in Sunkoshi Rural municipality - 01 of Sindhuli district. It is located near the BP Highway and meeting point of Ghyampe khola with Roshi River at Aapghari. It is about 52 km from Banepa. The source of material is deposit of Ghyampe Khola. After every rainy season, materials (Stone, gravel, sand etc.) are deposited at this area and collected these materials & crushed in crusher plant.

1.6.4 Om Buddha Crusher, Kamere (Sunkoshi -02, Sindhuli)

This quarry is located in Sunkoshi Rural municipality -02 of Sindhuli district. It is located near the BP highway & on the bank of Sunkoshi River. It is about 57 km from the Banepa. The source of material is deposite of Sunkoshi River.

1.7 Research Objective

The general objective of this research is to study the suitability of the various nearby local resources for the use in different layers of flexible pavement road construction in the Kathmandu valley or nearby. This will finally promote the utilization of local resources enhancing the promotion of the business and thus reducing the transportation cost.

Specific Objective

The specific objective of this research is listed as below:

- To compare the quality of various aggregate sources of Kavre and Sindhuli district for road construction based on different standard tests as per Standard Specification for Road and Bridge Works, 2073.
- To recommend the best site for the construction materials.
- To define suitability of different aggregate sources based on tests.

1.8 Assumption and Limitations

Assumption:

The assumptions for the study are given below:

- The sample aggregate chosen will define the source.
- The limited tests performed for the aggregate sources would represent the quality of the quarry.
- Standard specification of road and bridge work 2058 will be chosen for the analysis of gradation of sub base and base layers and SSRBW, 2073 will be adopted for rest of the tests and analysis.

Limitation:

- The study is limited to only the quarries of Kavre and Sindhuli district and its nearby areas.
- Properties of materials like polished stone value and deleterious material & organic impurities are not considered in this research.

CHAPTER 2 LITERATURE REVIEW

2.1 Properties of the Road Construction Materials and Its Importance

The performance of a pavement reflects the proper functioning of the consecutive component layers of a given pavement. The design period, life of the pavement, durability and maintenance cost can be explained by the selection of materials and their characteristics (Satyanarayana, Teja, Harshanandan, & Chandra, 2013).

The HMA stripping resistance was found to be significantly affected by the type of aggregate used in preparing the mix. HMA prepared using aggregate gradation followed upper limits of ASTM specification for dense graded showed the highest resistance to stripping, followed by HMA prepared using aggregate gradation followed mid-limits of ASTM specification for dense gradation. The work shows the importance of gradation in defining aggregate properties (Abo-Qudais & Al-Shweily, 2007).

Considering the other parameter such as voids ratio, percentage voids and maximum dry densities into account, it is identified that a dosage of 20-30% crusher dust make the gradation mixes dense and offer more shear strength due to mobilization of friction resistance under compression (Satyanarayana et al., 2013).

The aggregates 'age' as a result of a physical and mineralogical weathering process. Degradation of coarse rocks and the production of detrimental clay minerals considered as indications of weather ability of materials (Sangsefidi, Wilson, Larkin, & Black, 2017).

It was found that by reducing the air voids percentage and voids in mineral aggregate up to the certain amount, resilient modulus of the mixture will be increased and therefore deformation and non-recoverable strained will reduced (Golalipour, Jamshidi, Niazi, Afsharikia, & Khadem, 2012).

The CBR curve becomes gentler and the CBR values increase when the friction coefficient at the contact increases, CBR value increases linearly with shear modulus, the influence of poisons' ratio on the CBR numerical tests is not significant (Jiang, Wong, & Ren, 2015).

The CBR test acts as an attempt to quantify the behavioral characteristics of a soil trying to resist deformation when subjected to a locally applied force such as a wheel load (Rogers, 2003).

Finer content in the aggregates also affects the CBR value. The relationship between several variables such as fine contents, flakiness index, plasticity index, gradation, density, shear strength and permeability of unbound base course with respect to CBR were determined.

2.2 Desirable Properties of Aggregates and Their Tests

2.2.1 Desirable Properties of Aggregates

Aggregates must be strong, hard, tough, and durable and should have in proper shape and sizes, good adhesion and cementation characteristics. The parameters like strength, hardness, toughness, durable, proper shape, proper gradation and good adhesion or cementation are used to determine whether the selected road aggregates possess desirable properties or not (Rao & V. Mathew, 2007).

Strength

The aggregates used in top layers are subjected to

(i) Stress action due to traffic wheel load,
(ii) Wear and tear,
(iii) Crushing.

For a high quality pavement, the aggregates should posse's high resistance to crushing, and to withstand the stresses due to traffic wheel load.

Hardness

The aggregates used in the surface course are subjected to constant rubbing or abrasion due to moving traffic. The aggregates should be hard enough to resist the abrasive action caused by the movements of traffic. The abrasive action is severe when steel tired vehicles moves over the aggregates exposed at the top surface.

Toughness

Resistance of the aggregates to impact is termed as toughness. Aggregates used in the pavement should be able to resist the effect caused by the jumping of the steel tyre

wheels from one particle to another at deferent levels causes' severe impact on the aggregates.

Shape of Aggregates

Aggregates which happen to fall in a particular size range may have rounded cubical, angular, flaky or elongated particles. It is evident that the flaky and elongated particles will have less strength and durability when compared with cubical, angular or rounded particles of the same aggregate. Hence too flaky and too much elongated aggregates should be avoided as far as possible.

Adhesion with Bitumen

The aggregates used in bituminous pavements should have less affinity with water when compared with bituminous materials otherwise the bituminous coating on the aggregate will be stripped off in presence of water.

Durability

The property of aggregates to withstand adverse action of weather is called soundness. The aggregates are subjected to the physical and chemical action of rain and bottom water, impurities there-in and that of atmosphere, hence it is desirable that the road aggregates used in the construction should be sound enough to withstand the weathering action.

Free from Deleterious Particles

Specifications for aggregates used in bituminous mixes usually require the aggregates to be clean, tough and durable in nature and free from excess amount of or elongated pieces, dust, clay balls and other objectionable material. Similarly aggregates used in Portland cement concrete mixes must be clean and free from deleterious substances such as clay lumps, silt and other organic impurities (Mathew & Rao, 2007).

2.2.2 Tests on Aggregates

Tests on aggregates may be arbitrarily divided into different groups as shown below(Rao & V. Mathew, 2007)

Crushing Test

This test is done to determine the crushing strength of aggregates.

Abrasion Test

Abrasion test is carried out to test the hardness property of aggregates and to decide whether they are suitable for different pavement construction works. Los Angeles abrasion test is a preferred one for carrying out the hardness property.

Impact Test

The aggregate impact test is carried out to evaluate the resistance to impact of aggregates.

Soundness Test

Soundness test is intended to study the resistance of aggregates to weathering action, by conducting accelerated weathering test cycles. As per Standard Specification of Road & Bridge works, if water absorption is more 2 %, then soundness test shall be carried out.

Shape Test

The particle shape of the aggregate mass is determined by the percentage of flaky and elongated particles in it. Aggregates which are flaky or elongated are detrimental to higher workability and stability of mixes.

Specific Gravity and Water Absorption Test

The specific gravity and water absorption of aggregates are important properties that are required for the design of concrete and bituminous mixes. The specific gravity of a solid is the ratio of its mass to that of an equal volume of distilled water at a specified temperature.

Bitumen Adhesion Test

Bitumen adheres well to all normal types of road aggregates provided they are dry and free from dust. This is done by Stripping value of aggregate.

2.3 Codal Provision for Aggregate Tests and Their Suitability

Standard Specification for Road and Bridge Works, 2073 is a specification of different civil works required for road and bridge construction activities which was published by Department of Road, Ministry of Physical Infrastructure and Transport (MoPIT), Government of Nepal. The code has also provided standard tests involved

in representation of the quality of aggregates for use in different layers of pavement. The table shown below is referred from SSRBW, 2073 which is also the basis for the further study of suitability of quarries (DoR, 2015).

2.3.1 Sieve Analysis/ Gradation

Grain size analysis is a mechanical analysis of the provided soil in the determination of the percent of the individual grain sizes present in the sample. Dry Sieve analysis is carried out for the gradation. For the sampling and gradation of materials, IS sieves were used. The samples for sub-base, base, surface course are sieved through sieves for their respective gradation sieves as per specification.

2.3.2 Moisture Content

This test is carried out in laboratory for the determination of moisture content of soils and aggregates. It is the ratio of the mass of water to the mass of solids. The properties of soil like shear strength and compaction characteristics are greatly influenced by its water content.

2.3.3 Atterberg's Limit

The water contents at which the soil changes from one state to the other are known as consistency limits or Atterberg's limits. The fraction of natural gravel passing through 0.425 mm sieve, analyzed for atterberg's Limit to obtain

i. Liquid Limit
ii. Plastic Limit
iii. Plasticity Index

2.3.4 Flakiness Index

The plastic shape of aggregate is determined by the percentage of flaky and elongated particles contained in it. For base course and construction of bituminous and cement concrete types, the presence of flaky and elongated particles are considered undesirable as they may cause inherent weakness with possibilities of breaking down under heavy loads.

The flakiness index of aggregates is the percentage by weight of particles whose least dimension is less than three fifths (0.6) of their mean dimension. The test is not applicable to the size smaller than 6.3 mm.

2.3.5 Aggregate Crushing Value

The mechanical properties required in road aggregates are: a) satisfactory resistance to crushing under the roller during construction and b) adequate resistance to surface abrasion under traffic. Also surface stresses under rigid tyre rims of heavily loaded animal drawn vehicles are high enough to consider the crushing strength of road aggregates as an essential requirement.

The sample taken for aggregate crushing test should pass through 12.5 mm sieve and retained on 10 mm sieve thus after crushing with an application of total load 40 tones the crushed material is sieved on 2.36 mm sieve. The material that passes this sieve is collected.

2.3.6 Aggregate Crushing Ratio

This test describes the procedure for determining the percentages of the crushed aggregates. Crushed aggregates means at least two faces of the aggregates should be fractured. Crushing ration furnishes the information which is helpful in judging the interlocking / bonding characteristics of the aggregates.

2.3.7 California Bearing Ratio

It is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material. The California Bearing Ratio Test (CBR Test) is a penetration test developed by California State Highway Department (U.S.A.) for evaluating the bearing capacity of sub-grade soil for design of flexible pavement.

The CBR test is one of the most commonly used methods to evaluate the strength of a sub grade soil, sub-base, and base course material for design of thickness for Road and airfield pavement. The California Bearing Ratio test is penetration test meant for the evaluation of sub-grade strength of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers. This is the most widely used method for the design of flexible pavement.

2.4 Desirable Properties of Materials and Tests for Different Layers of Flexible Pavement.

2.4.1 Sub Grade

Soil having the following properties is suitable for preparation of sub-grade.

Liquid limit (LL) < 75% and

Plasticity Index (PI) <40

2.4.2 Sub Base Course

Granular sub-base should have following physical properties as per SSRBW, 2073, table 12.

Table 2-1 Physical Properties of Sub Base Materials

Tests	**Test method**	**Requirement for Class I & II**	**Requirement for Class III , IV and maintenance work**
Aggregate Impact Value (AIV)	IS 2386-4 or IS 5640	Maximum 40	Maximum 45
Liquid Limit	IS 2720-5	maximum 25	maximum 25
Plasticity Index	IS 2720-5	Maximum 6	Maximum 6
CBR at 95 % dry density (at IS 2720-part8)	IS 2720-5	Minimum 30 unless specified in the Contract	Minimum 25 unless specified in the Contract

2.4.3 Base Course

The general physical properties of crusher run aggregates for base course as per SSRBW, 2073 table 12.9 is shown as follows.

Table 2-2 Physical Properties of Base Material

Test	Test method	Requirements
Loss Angeles Abrasion Value(LAA) or Aggregate Impact Value (AIV)	IS: 2386 -4	40 max 30 max
Combined Flakiness & Elongation Index	IS: 2386 -1	35 max
Water Absorption	IS: 1386 -3	2 % max
Liquid limit of material passing 425μ	IS: 2720- 5	25 max
Plasticity index of material passing 425μ	IS: 2720- 5	6 max

2.4.4 Surface Dressing

Surface dressing is one of the most common and cost effective techniques used as wearing course. Main function of surface dressing is

i. To provide a dust free surface over a base course
ii. To provide a water proof layer to prevent infiltration of surface water
iii. To protect the base course.

The general physical properties of surface dressing as per SSRBW, 2073 table 13.13 is shown as follows.

Table 2-3 Physical Properties of Surface Dressing Material

Property.	**Test**	**Specification / Requirement**	**Test Method**
Cleanliness (dust)	Grain size analysis	Max 1.5% passing 0.075 mm sieve	IS : 2386 (Part-1)
Particle shape	Combine Flakiness and Elongation Indices (Total)	Max 35 %	IS : 2386 (Part-1)
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 35 5 Max 27 %	IS : 2386 (Part-4
Durability	Soundness: Sodium sulphate or Magnesium sulphate	Max 12 % Max 18 %	IS : 2386 (Part-5)
Water Absorption	Water absorption	Max 1%	IS : 2386 (Part-3)
Stripping	Coating and stripping of aggregate mix	Minimum retained coating 95 %	IS: 6241
Polishing	Polished Stone Value	Min 60	BS:812-114

2.4.5 Bituminous Macadam / Dense Bituminous Macadam/ Asphalt Concrete

Bituminous Macadam consists of one or more course of compacted crushed aggregate premixed with a bituminous binder and laid immediately after mixing and the compacted. The finished thickness of this premix when laid is 5 or 7.5cm and the size of aggregate depends on thickness of layer and the maximum size is limited to 37mm in 7.5cm thick premix. The layer of this type of the pavement is open graded premix and used as base course, if laid as surface course at least seal coat is necessary.

Dense Bituminous Macadam (DBM) is a binder course used for roads with more numbers of heavy commercial vehicles and a closed graded premix material having voids concept of 5-10 percent.

Bituminous Concrete (Asphalt Concrete) is the dense graded premixed bituminous mixture consisting of carefully proportioned mixture of dry coarse aggregate, fine aggregate, mineral filler and bitumen. When properly designed with appropriate proportion of ingredients, it will provide a surfacing of exceptional durable and capable in carrying the heaviest traffic. It is the highest quality of construction among the group of black top pavements. Asphalt concrete means a thoroughly controlled, hot mix, hot laid, plant mixture of well graded dried aggregate and penetration grade bitumen, which when compacted forms a dense material. Generally filler plays an important role in properties of bituminous mixture particularly in terms of air voids, voids in mineral aggregate. Different types of mineral fillers are used in the HMA mixes such as stone dust, ordinary Portland cement (OPC), slag cement, fly Ash, hydrated lime etc. (DoR, 2015).

The general physical properties of Bituminous Macadam (BM), Dense Bituminous Macadam (DBM) and Asphalt Concrete (AC) as per SSRBW, 2075 table 13.24, 13.26 and 13.32 is shown as follows.

Table 2-4 Physical Properties of BM, DBM and AC Aggregates Material

Property	**Test**	**Specification**	**Method of**
Cleanliness(dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS:2386 Part I
Particle shape	Combined Flakiness and Elongation Indices	Max 35%	IS:2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 30% (for BM 40% & for DBM 35%) Max 24% (for BM 30% & for DBM 27%)	IS:2386 Part IV
Durability	Soundness either: Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS:2386 Part V
Polishing	Polished Stone Value	Min 55 only for AC	BS:812-114
Water Absorption	Water Absorption	Max 2%	IS:2386.Part Ill
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS: 6241
Water Sensitivity	Retained Tensile Strength*	Min 80%	AASHTO 283

CHAPTER 3 METHODOLOGY

3.1 Collection of Aggregates from Quarries for Different Layer

All quarries produce different quality material as per the road site construction activity needs. Different standards have set different limits for different layers in terms of its physical properties. Thus, collection of materials would be performed for

i. Sub-base layers (SB)
ii. Base layers (B)
iii. Bituminous Macadam (BM)
iv. Dense Bituminous Macadam (DBM)
v. Asphalt Concrete (AC)

Materials satisfying the surface dressing were not found in any of these quarries of Kavre and Sinduli districts.

The above mentioned layers are selected based on its dominant use in the construction field herein Nepal. So, materials from four quarries namely Chalaal Ganeshthan, Bhyakur Khola (Kalo dhunga , Mangaltar), Ghyampe Khola (Aapghari), Om Buddha Crusher, Kamere of Kavre and Sindhuli District are collected to check the suitability of these aggregates for different layers of flexible pavement.

3.2 Tests on Aggregate

After the collection, different experiment sets, as from recommendation of SSRBW, 2058 and 2073, were performed. The experiments recommended for the study are tabulated below:

3.2.1 Test Results of Sub- Base Course

Table 3-1 Test Results of Sub- Base Course

Pavement Component	Test Name		Test Result of Sub base			
			Chalaal Ganeshsthan	**Ghyampe Khola (Aapghari)**	**Om Buddha, Kamere**	**Bhyakur Khola (Kalo Dhunga)**
Sub Base Course	Sieve Analysis / Gradation (Class-SB2, SSRBW, 2058)	Sieve size, mm	% Passing by wt.	% Passing by wt.	% Passing by wt.	% Passing by wt.
		63.00	100.0	100.0	100.0	100.0
		40.00	98.1	99.8	99.1	97.8
		31.50	86.9	90.8	88.1	84.7
		20.00	71.0	78.6	72.1	62.9
		10.00	54.1	59.3	61.4	53.3
		4.75	26.7	30.0	26.7	30.6
		2.36	19.9	19.2	13.3	17.0
		0.60	14.6	16.9	8.7	11.0
		0.075	7.9	7.2	5.3	5.9
	MDD		2.205	2.225	2.173	2.224
	OMC		6.50%	6.30%	5.75%	6.70%
	PI		Non plastic	Non plastic	Non plastic	Non plastic
	CBR at 95% compaction		73%	75%	76%	68%
	AIV same as base		27.97%	19.75%	18.61%	27.44%

The result of sub base materials from all quarries are in useable range as per SSRBW 2073. The gradation of sub base materials of all quarries follow the specification as per SSRBW 2058 because of unavailability of sieve size required foe SSRBW 2073. Gradation of all materials obtained from crusher fulfill the gradation requirement i.e. within grading Envelope. With respect to CBR and AIV, Om Buddha crusher of Kamere, Sindhuli is better for sub base but this quarry is more far from the other quarried from Kathmandu valley.

3.2.2 Test Result of Base Course

Table 3-2 Test Result of Base Course

Pavement Component	Tests		Test Results			
			Chalaal Ganesh.	**Ghyampe Khola (Aapghari)**	**Om Buddha, Kamere**	**Bhyakur Khola (Kalo Dhunga)**
Base Course	Analysis/ Gradation (SSRBW, 2058)	Sieve size, mm	% Passing by wt.	% Passing by wt.	% Passing by wt.	% Passing by wt.
		40.00	100.0	99.6	99.4	99.3
		31.50	88.6	87.0	85.1	86.9
		20.00	74.0	72.3	68.4	66.6
		10.00	57.5	54.2	53.9	49.4
		4.75	31.5	29.8	27.6	28.0
		2.36	25.3	26.3	24.1	25.2
		0.60	18.6	17.4	13.0	18.0
		0.075	9.8	6.9	7.1	7.3
	LAA		38.08%	30.43%	33.81%	37.15%
	AIV		27.97%	19.75%	18.61%	27.44%
	MDD		2.238	2.248	2.245	2.243
	OMC		6.20%	5.90%	6.25%	6.50%
	PI		Non plastic	Non plastic	Non plastic	Non plastic
	CBR at 98% compaction		93%	84%	94%	95%
	Water Absorption		0.85%	0.53%	0.52%	0.75%
	Combined FI and EI		33.98%	30.79%	28.81%	33.73%
	Crushing ratio (CR)		92.95%	89.31%	86.87%	85.42%

The result of base materials from all quarries are in useable range as per SSRBW 2073. The gradation of the base materials of all quarries follow the specification as per SSRBW 2058, because of unavailability of sieve size required for SSRBW 2073. Gradation of all materials obtained from crusher fulfill the gradation requirement i.e. within grading Envelope. With respect to LAA & MDD, Ghyampe Khola (Aapghari) quarry has better quality material from all four quarries but with respect to AIV & water absorption value, Om Buddha crusher, Kamere is better than other. Also interlocking property of Chalaal Ganeshthan is better than other quarries because of

high crushing ratio (CR). The water absorption value of all quarries are less than 2%, so soundness test may not be required as per SSRBW 2073.

3.2.3 Test Results of Bituminous Macadam

Table 3-3 Test Results of Bituminous Macadam

Pavement component	Test		Test Result				SSRBW ,2073
	Name		Challal Ganesh.	Aapghari (Ghampe Khola)	Bhyakur Khola	Om Buddha	
Bituminous Macadam	Sieve Analysis/ Gradation for 19mm Nominal maximum size aggregate	Sieve size, mm	% Passing by wt.	% Passing by wt.	% Passing by wt.	% Passing by wt.	
		26.5	99.41%	100.00%	100.00%	100.00%	100
		19.0	90.29%	89.57%	94.12%	95.94%	90-100
		13.2	78.94%	69.53%	70.97%	72.53%	56-88
		10.0	61.11%	64.50%	42.30%	49.26%	
		4.75	19.26%	17.48%	17.48%	21.25%	16-36
		2.36	16.06%	15.70%	13.91%	18.71%	4-19
		1.18	11.47%	13.48%	10.60%	13.77%	
		0.60	9.2%	11.57%	9.26%	11.57%	
		0.30	6.95%	7.69%	6.96%	7.69%	2-10
		0.15	6.22%	5.35%	5.11%	5.00%	
		0.075	3.83%	4.19%	4.07%	3.78%	0-8
	LAA		26.05%	28.49%	32.30%	29.35%	Max. 35%
	AIV		18.65%	19.75%	27.38%	18.61%	Max. 30%
	Combined FI and EI		34.06%	33.61%	33.32%	34.74%	Max. 35%
	Water Absorption		0.49%	0.97%	0.75%	0.58%	Max. 2%
	Stripping		Greater than 95%	Greater than 95%	Greater than 95%	Greater than 95%	
	PI		Non plastic	Non plastic	Non plastic	Non plastic	

Gradation analysis shows that the material from all of the four quarries meets the specification for Bituminous Macadam as per SSRBW, 2073. Gradation is done for the surface layer having normal maximum aggregate size 19mm for all the quarries. Along with the gradation requirement other properties like LAA, AIV, Stripping value,

combined FI and EI and water absorption shows that the materials from all the quarries meets the specification for Bituminous Macadam as per SSRBW, 2073.

3.2.4 Test Results of Dense Bituminous Macadam

Table 3-4 Test Results of Dense Bituminous Macadam

Pavement component	Test		Test Result				SSRBW,2073
	Name		Challal Ganesh.	Aapghari (Ghampe Khola)	Bhyakur Khola	Om Buddha	
Dense Bituminous Macadam	Sieve Analysis/ Gradation for 26.5 mm Nominal size aggregate	Sieve Size, mm	% Passing by wt.	% Passing by wt.	% Passing by wt.	% Passing by wt.	
		37.50	100.0%	100.00%	100.00%	100.00%	100
		26.50	98.41%	100.00%	100.00%	100.00%	90-100
		19.00	90.28%	89.87%	95.09%	95.26%	71-95
		13.20	79.05%	70.40%	75.80%	67.95%	56-80
		10.00	67.05%	66.67%	57.98%	54.34%	
		4.75	38.18%	30.81%	42.27%	38.51%	38-54
		2.36	32.01%	29.21%	31.28%	34.54%	28-42
		1.18	23.08%	25.34%	23.84%	25.40%	
		0.60	18.31%	21.65%	20.84%	21.10%	
		0.30	14.21%	14.72%	15.65%	14.82%	7-21
		0.15	12.73%	10.20%	11.49%	9.57%	
		0.075	7.83%	7.85%	9.16%	7.19%	2-8
	LAA		26.05%	28.49%	32.30%	29.35%	Max. 35%
	AIV		18.65%	19.75%	27.38%	18.61%	Max. 27%
	Combined FI and EI		34.06%	33.61%	33.32%	34.74%	Max. 35%
	Water Absorption		0.49%	0.97%	0.75%	0.58%	Max. 2%
	Stripping		Greater than 95%	Greater than 95%	Greater than 95%	Greater than 95%	
	PI		Non plastic	Non plastic	Non plastic	Non plastic	

Gradation analysis shows that the material from all of the four quarries meets the specification for Dense Bituminous Macadam as per SSRBW, 2073. Gradation is done for the surface layer having nominal aggregate size 26.5 mm for all the quarries.

Along with the gradation requirement other properties like LAA, AIV, Stripping value, combined FI and EI and water absorption shows that the materials from all the quarries except Bhyakur Khola (AIV greater than 27%) meets the specification for Dense Bituminous Macadam as per SSRBW, 2073.

So it can be recommended that the materials from these all quarries except Bhyakur Khola can be used for Dense Bituminous Macadam of flexible pavement as per SSRBW, 2073.

3.2.5 Test Results of Asphalt Concrete

Gradation analysis shows that the material from all of the four quarries meets the specification for Asphalt Concrete as per SSRBW, 2073. Gradation is done for nominal aggregate size 19 mm for all the quarries.

Along with the gradation requirement other properties like LAA, AIV, Stripping value, combined FI and EI and water absorption shows that the materials from all the quarries meets the specification for Asphalt Concrete except Bhyakur Khola (AIV greater than 24%) as per SSRBW, 2073.

So it can be recommended that the materials from these all quarries can be used for Asphalt Concrete of flexible pavement except Bhyakur Khola as per SSRBW, 2073.

In case of Bituminuous course material , the materials are crushed from the heavy and strong stone that impart the higher strength with respect to the materials of base and sub base of the same quarry.

Table 3-5 Test Results of Asphalt Concrete

Pavement component	Test		Test Result				SSRBW,2073
	Name		Challal Ganesh.	Aapghari (Ghampe Khola)	Bhyakur Khola	Om Buddha	
Asphalt Concrete	Sieve Analysis/ Gradation for 19 mm Nominal size aggregate	Sieve size, mm	% Passing by wt.	% Passing by wt.	% Passing by wt.	% Passing by wt.	
		26.5	98.30%	100.00%	100.00%	100.00%	100%
		20	89.6%	91.06%	95.10%	96.62%	90-100
		13.2	77.56%	73.89%	75.81%	77.11%	59-79
		10	65.19%	69.76%	57.45%	58.42%	52-72
		4.75	36.52%	30.95%	35.63%	35.24%	35-55
		2.36	30.60%	29.29%	30.59%	31.45%	28-44
		1.18	22.07%	25.39%	23.31%	23.14%	20-34
		0.6	17.95%	21.31%	20.38%	19.29%	15-27
		0.3	13.57%	14.74%	15.31%	13.26%	10-20
		0.15	12.16%	10.22%	11.24%	8.55%	5-13
		0.075	7.48%	7.98%	8.96%	6.41%	2-8
	LAA		26.05%	28.49%	32.30%	29.35%	Max. 35%
	AIV		18.65%	19.75%	27.38%	18.61%	Max. 27%
	Combined FI and EI		34.06%	33.61%	33.32%	34.74%	Max. 35%
	Water Absorption		0.49%	0.97%	0.75%	0.58%	Max. 2%
	Stripping		Greater than 95%	Greater than 95%	Greater than 95%	Greater than 95%	
	PI		Non plastic	Non plastic	Non plastic	Non plastic	

3.2.6 Analysis of Result

As per the laboratory test result of physical properties, it is found that all the processed materials for every pavement component from each source are well graded. Compaction and mechanical strength of sub base from each source are good as maximum dry density is greater than 2.15g /cc and California bearing ratio is more than 60%. Also for base material of all sources, maximum dry density are more than 2.2g/cc , Los Angeles Abrasion (LAA) values are less than 40 %, Aggregate Impact value (AIV) are less than 30% , combined Flakiness & Elongation Index are less than 35 % & crushing ration (CR) more than 80%. , all sources material are suitable for

base course. Similarly for Bituminous Macadam (open graded) of all sources, LAA is less than 40%, AIV is less than 30%, combined EI & FI is less than 35%, water absorption value is less than 2% & stripping value is more than 95 %, all sources material are suitable for bituminous macadam. Similarly for Dense Bituminous Macadam (DBM) of all sources, LAA is less than 35%, AIV is less than 27% except Bhyakur khola (27.38%), combined EI & FI is less than 35%, water absorption value is less than 2% & stripping value is more than 95 %, all sources except Bhyakur Khola material are suitable for bituminous macadam. Similarly for Asphalt concrete (AC) of all sources, LAA is less than 30% except Bhyakur Khola (32.30%) AIV is less than 24% except Bhyakur khola (27.38%), combined EI & FI is less than 35%, water absorption value is less than 2% & stripping value is more than 95 %, all sources except Bhyakur Khola material are suitable for Asphalt concrete.

3.2.7 Approximate Production Capacity of the Quarries

Chalaal Ganeshsthan Quarry

According to the information from crusher plant, at present, there are two crusher plant in operating condition at Chalaal Ganeshsthan Quarry. The production capacity of each of these crusher plant is about 35 tripper per day and the capacity of the tipper is 8 cum. During three months of the year (Ashad, Shrawan and Bhadra) these plants remains close. Assuming the crusher plants runs 60% of nine months (40% of nine months does not run due to various reasons such as maintenances, festivals etc.), the production of materials from this two crusher plants is 2*0.6*9*30*35*8= 90,720 cum/year.

Bhyakur Khola at Kalo Dhunga Quarry

According to the information from crusher plant, at present, there are three crusher plant in operating condition at Bhyakur Khola Quarry. The production capacity of each of these crusher plant is about 30 tripper per day and the capacity of the tipper is 8 cum. During three months of the year (Ashad, Shrawan and Bhadra) these plants remains close. Assuming the crusher plants runs 60% of nine months (40% of nine months does not run due to various reasons such as maintenances, festivals etc.), the production of materials from this two crusher plants is 3*0.6*9*30*30*8= 1,16,640 cum/year.

Ghyampe Khola (Aapghari) Quarry

According to the information from crusher plant, at present, there are three crusher plant in operating condition at Ghyampe Khola (Aapghari) Quarry. The production capacity of each of these crusher plant is about 30 tripper per day and the capacity of the tipper is 8 cum. During three months of the year (Ashad, Shrawan and Bhadra) these plants remains close. Assuming the crusher plants runs 60% of nine months (40% of nine months does not run due to various reasons such as maintenances, festivals etc.), the production of materials from this two crusher plants is 3*0.6*9*30*30*8= 1,16,640 cum/year.

Om Buddha (Kamere) Quarry

According to the information from crusher plant, at present, there are two crusher plant in operating condition at Om Buddha Quarry. The production capacity of each of these crusher plant is about 25 tripper per day and the capacity of the tipper is 8 cum. During three months of the year (Ashad, Shrawan and Bhadra) these plants remains close. Assuming the crusher plants runs 60% of nine months (40% of nine months does not run due to various reasons such as maintenances, festivals etc.), the production of materials from this two crusher plants is 2*0.6*9*30*25*8= 64,800 cum/year.

Analysis of Production Capacity

Among the four quarries, the production capacity of Bhyakur Khola at Kalo Dhunga Quarry and Ghyampe Khola (Aapghari) Quarry have found to be more production rate per year i.e. 1,16,640 cum/year , this indicates that these quarries will substitutes the need of aggregate at Kathmandu Valley. The production rate of Chalaal Ganeshsthan Quarry is found as equal to that of of Bhyakur Khola at Kalo Dhunga Quarry and Ghyampe Khola (Aapghari) Quarry i.e. 90,720 cum/year, the location is also near from Kathmandu Valley among rest of the three quarries. So, we can recommended firstly the Chalaal Ganeshsthan Quarry and then Bhyakur Khola at Kalo Dhunga Quarry and Ghyampe Khola (Aapghari) Quarry for the supply of aggregates at Kathmandu Valley on the basis of production rate and travel time.

CHAPTER 4 CONCLUSION

In this research work, we conducted different tests as per SSRBW-2073 for the analysis of crusher run materials usable for different layers of flexible pavement construction. The data for experiments are collected in a standard sheet and we found following outcomes:

1. The materials from different Quarries satisfy the standard for base and sub-base layers of flexible pavement.
2. Materials from Quarries of all the quarries satisfy the standard for bituminous macadam.
3. Except the materials from Bhyakur Khola quarry, materials from rest of the three quarries meets the standard for dense bituminous macadam and asphalt concrete of surface course of flexible pavement.
4. In case of Bituminuous course material, the materials are crushed from the heavy and strong stone that impart the higher strength with respect to the materials of base and sub base of the same quarry.
5. So, it can be recommended that, the materials for base, sub base and bituminous macadam can be taken from any of the quarries and for the quality materials for dense bituminous macadam and asphalt concrete firstly Challal Ganesh quarry is recommended and then Aapghari and Om Buddha quarries are recommended.
6. We can firstly recommended the Chalaal Ganeshsthan Quarry and then Bhyakur Khola at Kalo Dhunga Quarry and Ghyampe Khola (Aapghari) Quarry for the supply of aggregates at Kathmandu Valley on the basis of production rate and travel time.

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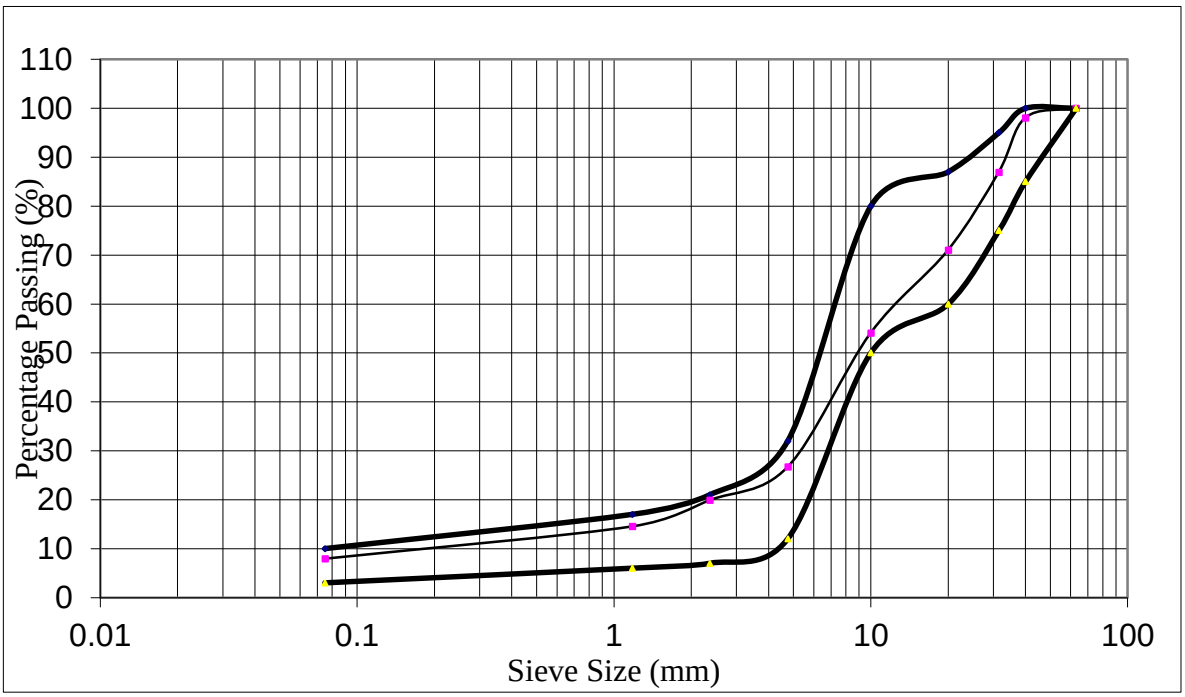
APPENDIX 1 LAB TESTS RESULTS OF SUB- BASE OF CHALAAL GANESH QUARRY

1. Sieve Analysis of Sub base (Chalaal Ganeshthan)

Sieve Size (mm)	Specification		Weight Retained (g)	Weight Passing (g)	% Passing
	Lower Limit	Upper Limit			
63.00	100.00	100.00	0.00	16673.0	**100.00**
40.00	85.00	100.00	324.0	16349.0	**98.1**
31.50	75.00	95.00	1854.0	14495.0	**86.9**
20.00	60.00	87.00	2654.0	11841.0	**71.0**
10.00	50.00	80.00	2822.0	9019.0	**54.1**
4.75	12.00	32.00	4565.0	4454.0	**26.7**
Pan			4454.0		
Total			16673.0		
2.36	7.00	21.00	168.0	491.0	**19.9**
1.18	6.00	17.00	132.0	359.0	**14.6**
0.075	3.00	10.00	163.0	196.0	**7.9**
Pan			196.0		
Rep. Total			**659.0**		



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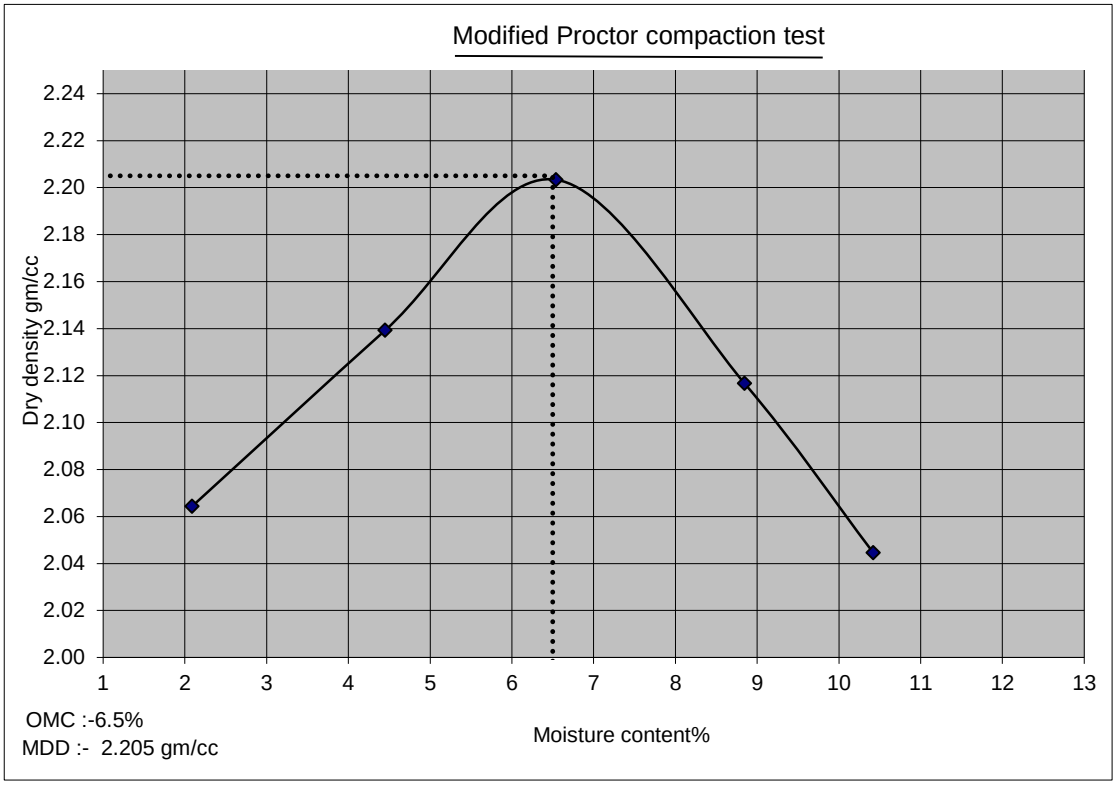
2. Modified Proctor Test of Sub base (Chalaal Ganeshthan)

Density

Test No.	1	2	3	4	5	6
Cylinder+Soil (g)	10356	10642	10896	10798	10694	
Cylinder (g)	5612	5612	5612	5612	5612	
Wet Soil (g)	4744	5030	5284	5186	5082	
Wet density(g/cc)	2.108	2.235	2.347	2.304	2.258	

Moisture content

Container No.	4	B	A	7	X	
Wt. of Wet soil+can(g)	1241.1	1364.3	1348.3	1344.7	1151.5	
Wt. of Dry soil+ can(g)	1224.5	1324.9	1292.8	1268.1	1082.0	
Wt. Can (g)	429.5	439.8	444.2	402.2	415.0	
Wt. of Dry soil (g)	795.0	885.1	848.6	865.9	667	
Et. Of Moisture (g)	16.6	39.4	55.5	76.6	69.5	
Moisture content (%)	2.09	4.45	6.54	8.85	10.42	
Dry density(g/cc)	2.064	2.139	2.203	2.117	2.045	



3. CBR of Sub Base (Chalaal Ganeshthan)

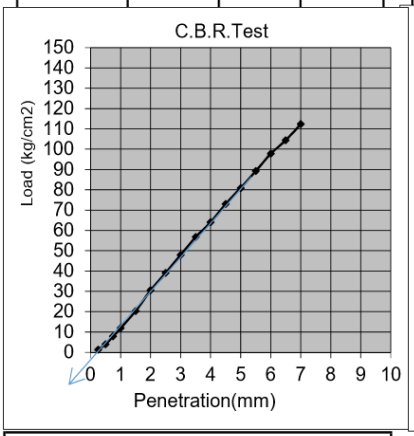
Test condition	Before Soaking			After Soaking		
Mould No.	C	M	A	C	M	A
No. of Blows per layer	60	30	10	60	30	10
Wt. of wet Sample + Mould (g)	12228.00	12190.00	11744.00	12268.00	12239.00	11806.00
Wt. of mould (g)	7026.00	7466.00	7396.00	7026.00	7466.00	7396.00
Wt. of wet sample (g)	5202.00	4724.00	4348.00	5242.00	4773.00	4410.00
Volume of mould (cc)	2216.00	2185.40	2188.37	2216.00	2185.40	2188.37
Wet density (g/cc)	2.347	2.162	1.987	2.366	2.184	2.015
Av. Moisture content (%)	6.66	6.70	6.55	7.60	7.89	8.33
Dry unit weight (g/cc)	2.201	2.026	1.865	2.198	2.024	1.860
MDD (g/cc)	2.205	2.205	2.205			
Compaction (%)	99.8	91.9	84.6			
Swelling				-	-	-
Water absorption (%)				0.77	1.04	1.43

Moisture Content Determination												
Test condition	Before Soaking						After Soaking					
Mould No.	C		M		A		C		M		A	
Can no.	1	2	3	4	5	6	1	2	3	4	5	6
Wt. of can + Wet soil (g)	840.2	930.5	839.4	997.6	784.6	873.5	832.7	873.9	985.7	954.9	867.5	974.7
Wt. of can + dry soil (g)	814.9	899.4	813.5	961.7	761.9	845.3	804.6	843.9	943.7	917.2	835.4	931.7
Wt. of water (g)	25.3	31.1	25.9	35.9	22.7	28.2	28.1	30.0	42.0	37.7	32.1	43.0
Wt. of empty can (g)	437.6	429.4	422.6	432.4	421.5	406.7	437.6	446.3	413.8	437.1	443.8	423.4
Wt. of dry soil (g)	377.3	470.0	390.9	529.3	340.4	438.6	367.0	397.6	529.9	480.1	391.6	508.3
Moisture content %	6.71	6.62	6.63	6.78	6.67	6.43	7.66	7.55	7.93	7.85	8.20	8.46
Av. Moisture content %	6.66		6.70		6.55		7.60		7.89		8.33	

CBR Test Data for Sub Base Course

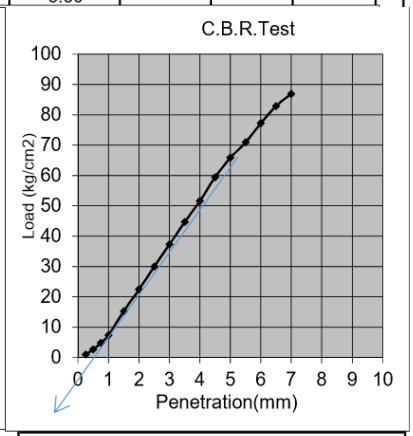
Material Type : Sub Base
Location : Bethanchowk -4, Kavre (Chalal Ganeshthan)

Penetration Test (60 blows)			
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	24.1	19.6	**1.2**
0.50	77.6	19.6	**4.0**
0.75	154.2	19.6	**7.9**
1.00	233.5	19.6	**11.9**
1.50	398.2	19.6	**20.3**
2.00	599.3	19.6	**30.6**
2.50	766.2	19.6	**39.1**
3.00	940.2	19.6	**48.0**
3.50	1112	19.6	**56.7**
4.00	1256	19.6	**64.1**
4.50	1430.1	19.6	**73.0**
5.00	1586.3	19.6	**80.9**
5.50	1749	19.6	**89.2**
6.00	1916.2	19.6	**97.8**
6.50	2047	19.6	**104.4**
7.00	2202	19.6	**112.3**



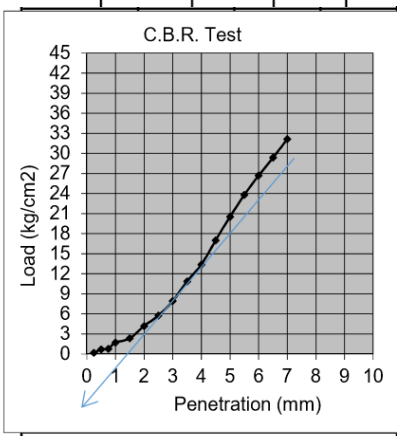
Corrected CBR at 2.5mm Penetration:
42 /70*100= **60.0** %
Corrected CBR at 5 mm Penetration:
81 /105*100 = **77.1** %
:. CBR = **77.1** %
Compaction = **99.8** %

Penetration Test (30 blows)			
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	18	19.6	**0.9**
0.50	52.2	19.6	**2.7**
0.75	94.2	19.6	**4.8**
1.00	144.2	19.6	**7.4**
1.50	299.3	19.6	**15.3**
2.00	439.2	19.6	**22.4**
2.50	587.2	19.6	**30.0**
3.00	730.2	19.6	**37.3**
3.50	875.2	19.6	**44.7**
4.00	1012.2	19.6	**51.6**
4.50	1165.2	19.6	**59.4**
5.00	1291	19.6	**65.9**
5.50	1390.2	19.6	**70.9**
6.00	1513.2	19.6	**77.2**
6.50	1625.2	19.6	**82.9**
7.00	1703	19.6	**86.9**
7.50			
8.00			
8.50			

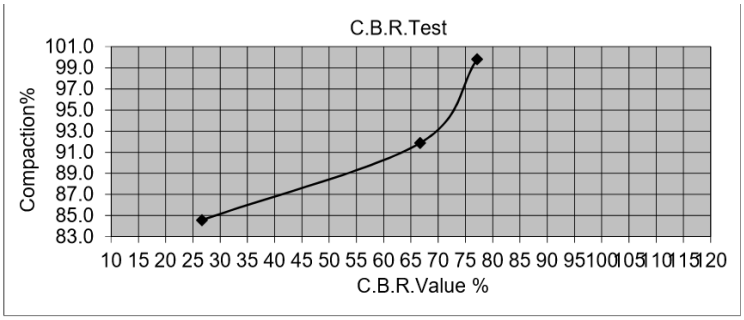


Corrected CBR at 2.5mm Penetration:
39.0 /70*100= **55.7** %
Corrected CBR at 5 mm Penetration:
70 /105*100 = **66.7** %
:. CBR = **66.7** %
Compaction = **91.9** %

Penetration Test (10 blows)			
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	3.5	19.6	**0.2**
0.50	13.6	19.6	**0.7**
0.75	15.6	19.6	**0.8**
1.00	33.2	19.6	**1.7**
1.50	46	19.6	**2.3**
2.00	82.3	19.6	**4.2**
2.50	112.6	19.6	**5.7**
3.00	155.2	19.6	**7.9**
3.50	212.5	19.6	**10.8**
4.00	262.4	19.6	**13.4**
4.50	333.2	19.6	**17.0**
5.00	402.4	19.6	**20.5**
5.50	466.2	19.6	**23.8**
6.00	523.3	19.6	**26.7**
6.50	575.2	19.6	**29.3**
7.00	630.2	19.6	**32.2**



Corrected CBR at 2.5mm Penetration:
13.0 /70*100= **18.6** %
Corrected CBR at 2.5mm Penetration:
28 /105*100 = **26.7** %
:. CBR = **26.7** %
Compaction = **84.6** %



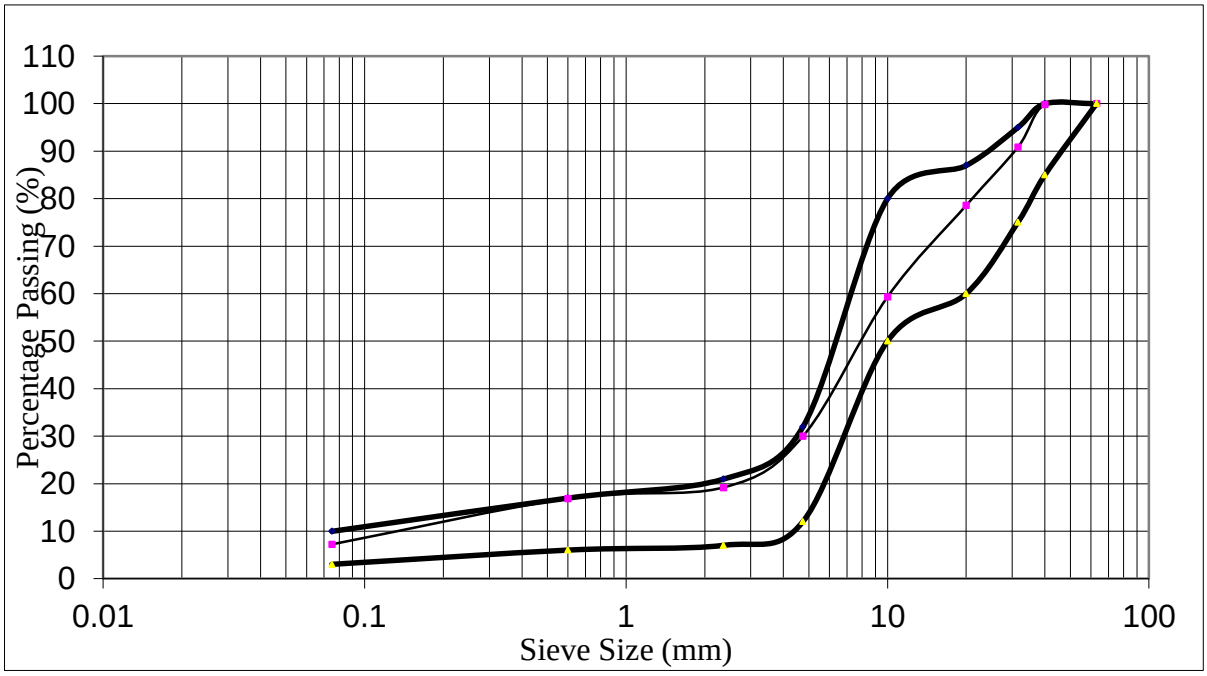
Test Result

:. C.B.R at 95% compaction= 73 %

APPENDIX 2 LAB TESTS RESULTS OF SUB- BASE OF AAPGHARI QUARRY

1. Sieve Analysis of Sub Base (Aapghari)

Sieve Size (mm)	Specification		Weight Retained (g)	Weight Passing (g)	% Passing
	Lower Limit	Upper Limit			
63.00	100.00	100.00	0.00	20355.0	**100.00**
40.00	85.00	100.00	35.0	20320.0	**99.8**
31.50	75.00	95.00	1830.0	18490.0	**90.8**
20.00	60.00	87.00	2490.0	16000.0	**78.6**
10.00	50.00	80.00	3920.0	12080.0	**59.3**
4.75	12.00	32.00	5970.0	6110.0	**29.9**
Pan			6110.0		
Total			20355.0		
2.36	7.00	21.00	254.3	450.9	**19.2**
0.60	6.00	17.00	54.3	396.6	**16.9**
0.075	3.00	10.00	227.2	169.4	**7.2**
Pan			169.4	0.0	
Rep. Total			**705.2**		



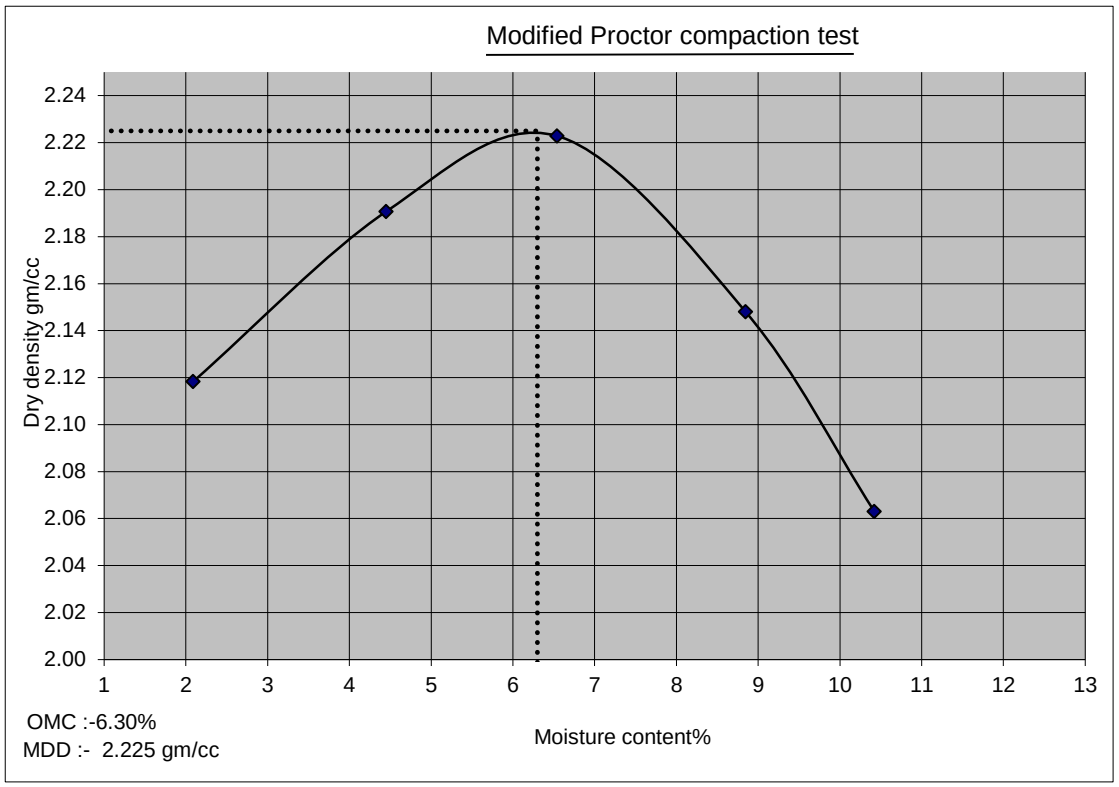
2. Modified Proctor Test of Sub Base (Aapghari)

Density

Test No.	1	2	3	4	5	6
Cylinder+ Soil (g)	10480	10763	10943	10875	10740	
Cylinder (g)	5612	5612	5612	5612	5612	
Wet Soil (g)	4868	5151	5331	5263	5128	
Wet density(g/cc)	2.163	2.288	2.368	2.338	2.278	

Moisture content

Container No.	7	B	A	7	X	
Wt. of Wet soil+ can(g)	1241.1	1364.3	1348.3	1344.7	1151.5	
Wt. of Dry soil+ can(g)	1224.5	1324.9	1292.8	1268.1	1082.0	
Wt. Can (g)	429.5	439.8	444.2	402.2	415.0	
Wt. of Dry soil (g)	795	885.1	848.6	865.9	667	
Et. Of Moisture (g)	16.6	39.4	55.5	76.6	69.5	
Moisture content (%)	2.09	4.45	6.54	8.85	10.42	
Dry density(g/cc)	**2.118**	**2.191**	**2.223**	**2.148**	**2.063**	



3. CBR of Sub Base (Aapghari)

Test condition	Before Soaking			After Soaking		
Mould No.	C	M	A	C	M	A
No. of Blows per layer	60	30	10	60	30	10
Wt. of wet Sample + Mould (g)	12245.00	12332.00	12029.00	12273.00	12378.00	12102.00
Wt. of mould (g)	7026.00	7466.00	7396.00	7026.00	7466.00	7396.00
Wt. of wet sample (g)	5219.00	4866.00	4633.00	5247.00	4912.00	4706.00
Volume of mould (cc)	2216.00	2185.40	2188.37	2216.00	2185.40	2188.37
Wet density (g/cc)	2.355	2.227	2.117	2.368	2.248	2.150
Av. Moisture content (%)	6.39	6.47	6.33	7.14	7.62	8.07
Dry unit weight (g/cc)	2.214	2.091	1.991	2.210	2.088	1.990
MDD (g/cc)	2.225	2.225	2.225			
Compaction (%)	99.5	94.0	89.5			
Swelling				-	-	-
Water absorption (%)				0.54	0.95	1.58

Moisture Content Determination												
Test condition	Before Soaking						After Soaking					
Mould No.	C		M		A		C		M		A	
Can no.	1	2	3	4	5	6	1	2	3	4	5	6
Wt. of can + Wet soil (g)	873.2	912.5	848.2	890.1	838.9	813.2	967.3	874.1	930.2	963.1	904.6	897.3
Wt. of can + dry soil (g)	845.7	882.6	822.1	861.4	814.9	790	932.7	844.9	896.2	924.8	869.7	862.6
Wt. of water (g)	27.5	29.9	26.1	28.7	24.0	23.2	34.6	29.2	34.0	38.3	34.9	34.7
Wt. of empty can (g)	422.7	406.7	413.8	423.4	437.6	421.5	446.6	437.5	443.8	429.4	432.4	437.1
Wt. of dry soil (g)	423.0	475.9	408.3	438.0	377.3	368.5	486.1	407.4	452.4	495.4	437.3	425.5
Moisture content %	6.50	6.28	6.39	6.55	6.36	6.30	7.12	7.17	7.52	7.73	7.98	8.16
Av. Moisture content %	6.39		6.47		6.33		7.14		7.62		8.07	

CBR Test Data for Sub Base Course

Material Type : Sub Base
Location : Aapghari

Penetration Test (60 blows)

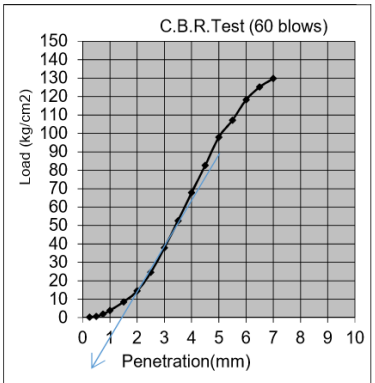
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	4.9	19.6	**0.3**
0.50	13.5	19.6	**0.7**
0.75	38	19.6	**1.9**
1.00	75.7	19.6	**3.9**
1.50	168.3	19.6	**8.6**
2.00	283.9	19.6	**14.5**
2.50	481.4	19.6	**24.6**
3.00	743.7	19.6	**37.9**
3.50	1032	19.6	**52.7**
4.00	1330.2	19.6	**67.9**
4.50	1620	19.6	**82.7**
5.00	1920.2	19.6	**98.0**
5.50	2100.4	19.6	**107.2**
6.00	2316.4	19.6	**118.2**
6.50	2453	19.6	**125.2**
7.00	2543.5	19.6	**129.8**

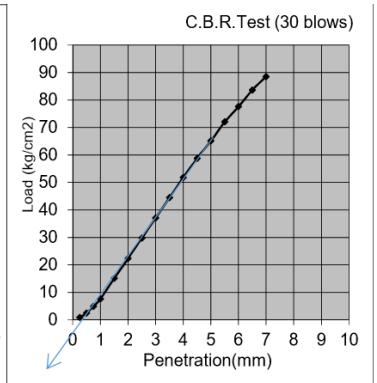
Penetration Test (30 blows)

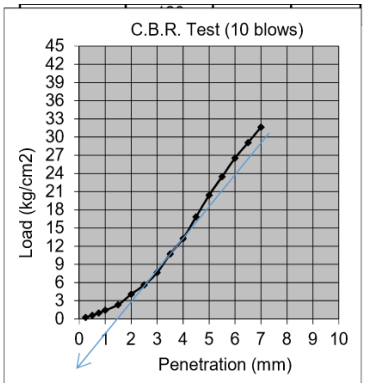
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	16.2	19.6	**0.8**
0.50	48.5	19.6	**2.5**
0.75	96.1	19.6	**4.9**
1.00	149.8	19.6	**7.6**
1.50	296	19.6	**15.1**
2.00	437.6	19.6	**22.3**
2.50	583.9	19.6	**29.8**
3.00	726.7	19.6	**37.1**
3.50	872.3	19.6	**44.5**
4.00	1016.2	19.6	**51.8**
4.50	1152.4	19.6	**58.8**
5.00	1276.9	19.6	**65.1**
5.50	1412.1	19.6	**72.0**
6.00	1520.6	19.6	**77.6**
6.50	1639.7	19.6	**83.7**
7.00	1735	19.6	**88.5**
7.50			
8.00			
8.50			

Penetration Test (10 blows)

Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	5	19.6	**0.3**
0.50	12	19.6	**0.6**
0.75	19	19.6	**1.0**
1.00	28	19.6	**1.4**
1.50	46	19.6	**2.3**
2.00	80	19.6	**4.1**
2.50	110	19.6	**5.6**
3.00	150	19.6	**7.7**
3.50	210	19.6	**10.7**
4.00	260	19.6	**13.3**
4.50	330	19.6	**16.8**
5.00	400	19.6	**20.4**
5.50	460	19.6	**23.5**
6.00	520	19.6	**26.5**
6.50	570	19.6	**29.1**
7.00	620	19.6	**31.6**



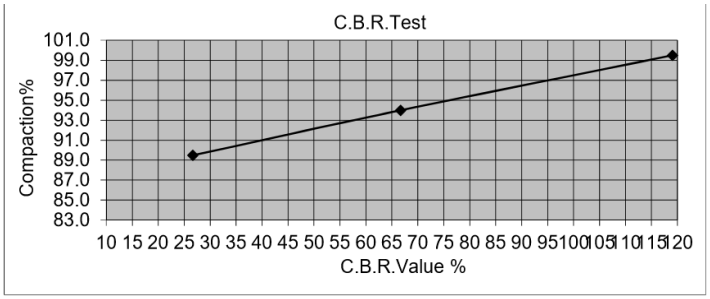




Corrected CBR at 2.5mm Penetration:
70 **/70*100= 100.0** %
Corrected CBR at 5 mm Penetration:
125 /105*100 = 119.0 %
:. CBR = **119.0** %
Compaction = **99.5** %

Corrected CBR at 2.5mm Penetration:
36.0 /70*100= 51.4 %
Corrected CBR at 5 mm Penetration:
70 /105*100 = 66.7 %
:. CBR = **66.7** %
Compaction = **94.0** %

Corrected CBR at 2.5mm Penetration:
13.0 /70*100= 18.6 %
Corrected CBR at 2.5mm Penetration:
28 /105*100 = 26.7 %
:. CBR = **26.7** %
Compaction = **89.5** %



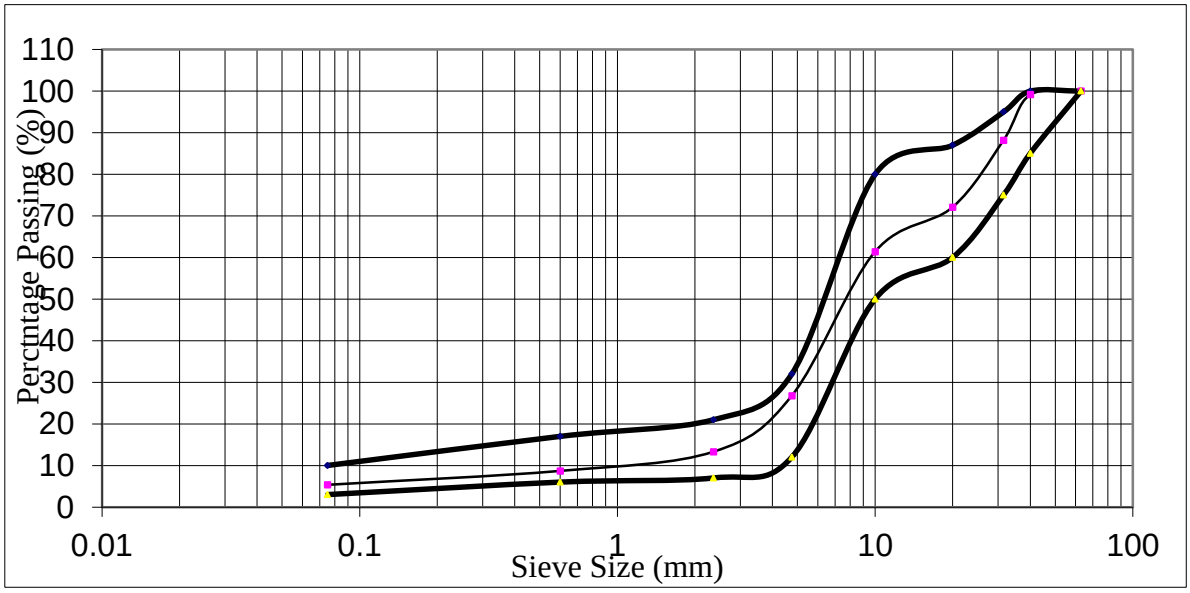
Test Result

:. C.B.R at 95% compaction= 75 %

APPENDIX 3 LAB TESTS RESULTS OF SUB- BASE OF OM BUDDHA QUARRY

1. Sieve Analysis of Sub Base (Om Buddha)

Sieve Size (mm)	Specification		Weight Retained (g)	Weight Passing (g)	% Passing
	Lower Limit	Upper Limit			
63.00	100.00	100.00	0.0	17026.0	**100.0**
40.00	85.00	100.00	150.0	16876.0	**99.1**
31.50	75.00	95.00	1868.0	15008.0	**88.1**
20.00	60.00	87.00	2734.0	12274.0	**72.1**
10.00	50.00	80.00	1824.0	10450.0	**61.4**
4.75	12.00	32.00	5900.0	4550.0	**26.7**
Pan			4550.0	0.0	
Total			17026.0		
2.36	7.00	21.00	357.7	354.0	**13.3**
0.60	6.00	17.00	122.8	231.2	**8.7**
0.075	3.00	10.00	89.2	142.0	**5.3**
Pan			142.0	0.0	**0.0**
Rep. Total			**711.7**		



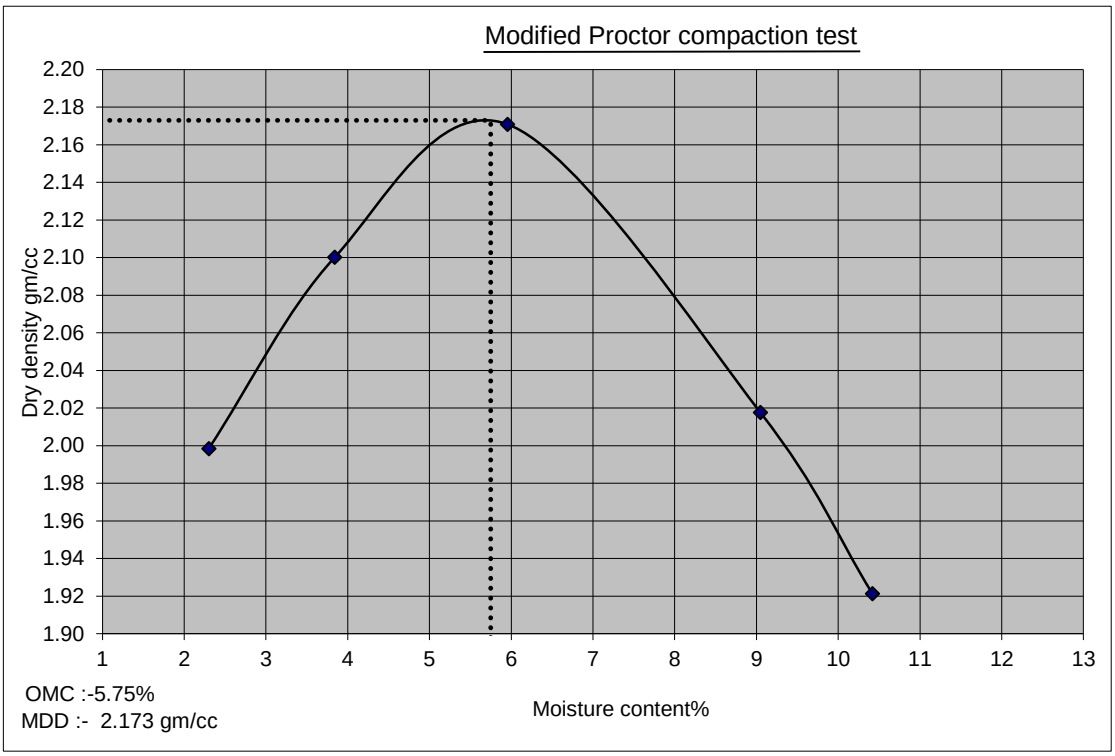
2. Modified Proctor Test of Sub Base (Om Buddha)

Density

Test No.	1	2	3	4	5	6
Cylinder+ Soil (g)	10257	10567	10838	10611	10432	
Cylinder (g)	5612	5612	5612	5612	5612	
Wet Soil (g)	4645	4955	5226	4999	4820	
Wet density(g/cc)	2.044	2.181	2.300	2.200	2.121	

Moisture content

Container No.	3	B	MO	A 6	Z	
Wt. of Wet soil+ can(g)	1080.6	1100.2	1021.8	1104.5	1072	
Wt. of Dry soil+ can(g)	1065.5	1075.8	988.0	1048.8	1010.0	
Wt. Can (g)	408.8	440.6	420.3	433.2	415.0	
Wt. of Dry soil (g)	656.7	635.2	567.7	615.6	595	
Et. Of Moisture (g)	15.1	24.4	33.8	55.7	62.0	
Moisture content (%)	2.30	3.84	5.95	9.05	10.42	
Dry density(g/cc)	**1.999**	**2.100**	**2.171**	**2.018**	**1.921**	



3. CBR of Sub Base (Om Buddha)

Test condition	Before Soaking			After Soaking		
Mould No.	C	M	A	C	M	A
No. of Blows per layer	60	30	10	60	30	10
Wt. of wet Sample + Mould (g)	12128.00	12162.00	11847.00	12307.00	12430.00	12123.00
Wt. of mould (g)	7026.00	7466.00	7396.00	7026.00	7466.00	7396.00
Wt. of wet sample (g)	5102.00	4696.00	4451.00	5281.00	4964.00	4727.00
Volume of mould (cc)	2216.00	2185.40	2188.37	2216.00	2185.40	2188.37
Wet density (g/cc)	2.302	2.149	2.034	2.383	2.271	2.160
Av. Moisture content (%)	6.43	6.51	6.31	7.09	8.13	8.17
Dry unit weight (g/cc)	2.163	2.017	1.913	2.225	2.101	1.997
MDD (g/cc)	2.173	2.173	2.173			
Compaction (%)	99.5	92.8	88.0			
Swelling				-	-	-
Water absorption (%)				3.51	5.71	6.20

Moisture Content Determination												
Test condition	Before Soaking						After Soaking					
Mould No.	C		M		A		C		M		A	
Can no.	1	2	3	4	5	6	1	2	3	4	5	6
Wt. of can + Wet soil (g)	912.1	870.4	904.6	890.5	812.7	865.2	924.1	906.2	775.2	864.1	856.4	894.2
Wt. of can + dry soil (g)	882.6	844.4	874.2	861.5	790.2	840	892.1	875.2	749.9	830.1	823.1	860.6
Wt. of water (g)	29.5	26.0	30.4	29.0	22.5	25.2	32.0	31.0	25.3	34.0	33.3	33.6
Wt. of empty can (g)	427.5	437.2	402.6	420.3	443.0	429.5	439.8	439.3	436.0	415.0	421.3	442.9
Wt. of dry soil (g)	455.1	407.2	471.6	441.2	347.2	410.5	452.3	435.9	313.9	415.1	401.8	417.7
Moisture content %	6.48	6.39	6.45	6.57	6.48	6.14	7.07	7.11	8.06	8.19	8.29	8.04
Av. Moisture content %	6.43		6.51		6.31		7.09		8.13		8.17	

CBR Test Data for Sub Base Course

Material Type : Sub Base
Location : Sunkoshi -2 ,Kamere, Sindhuli (Om Buddha crusher)

Penetration Test (60 blows)

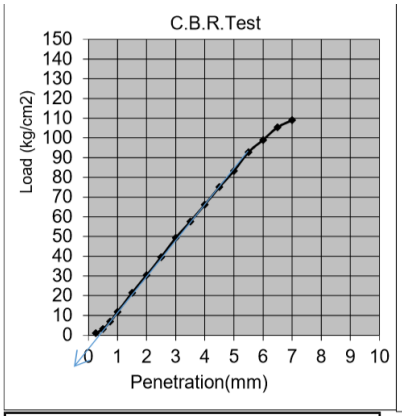
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	18.6	19.6	**0.9**
0.50	61.2	19.6	**3.1**
0.75	134.2	19.6	**6.8**
1.00	230.2	19.6	**11.7**
1.50	420.3	19.6	**21.4**
2.00	595.2	19.6	**30.4**
2.50	776.3	19.6	**39.6**
3.00	967.2	19.6	**49.3**
3.50	1128	19.6	**57.6**
4.00	1296.3	19.6	**66.1**
4.50	1472.2	19.6	**75.1**
5.00	1632.2	19.6	**83.3**
5.50	1817.6	19.6	**92.7**
6.00	1940.2	19.6	**99.0**
6.50	2065.3	19.6	**105.4**
7.00	2136	19.6	**109.0**

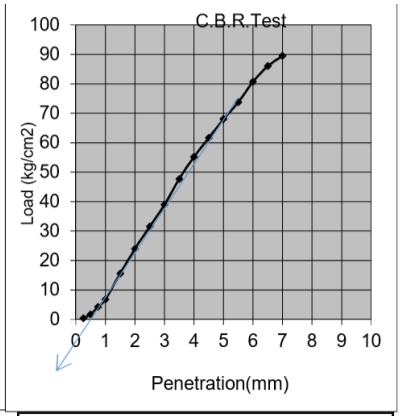
Penetration Test (30 blows)

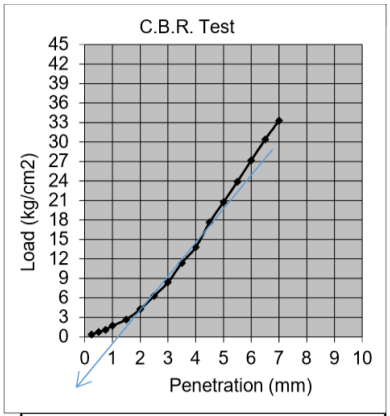
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	7.4	19.6	**0.4**
0.50	34.4	19.6	**1.8**
0.75	83.2	19.6	**4.2**
1.00	133.6	19.6	**6.8**
1.50	305.6	19.6	**15.6**
2.00	470.2	19.6	**24.0**
2.50	618.3	19.6	**31.5**
3.00	763.2	19.6	**38.9**
3.50	935.3	19.6	**47.7**
4.00	1082.5	19.6	**55.2**
4.50	1207.8	19.6	**61.6**
5.00	1332.8	19.6	**68.0**
5.50	1446	19.6	**73.8**
6.00	1582	19.6	**80.7**
6.50	1686	19.6	**86.0**
7.00	1754	19.6	**89.5**

Penetration Test (10 blows)

Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	7	19.6	**0.4**
0.50	14	19.6	**0.7**
0.75	21.3	19.6	**1.1**
1.00	33.2	19.6	**1.7**
1.50	52.2	19.6	**2.7**
2.00	83.5	19.6	**4.3**
2.50	123.2	19.6	**6.3**
3.00	164.2	19.6	**8.4**
3.50	223.2	19.6	**11.4**
4.00	270.2	19.6	**13.8**
4.50	345.2	19.6	**17.6**
5.00	406.4	19.6	**20.7**
5.50	468.2	19.6	**23.9**
6.00	532.2	19.6	**27.2**
6.50	595.2	19.6	**30.4**
7.00	652.2	19.6	**33.3**



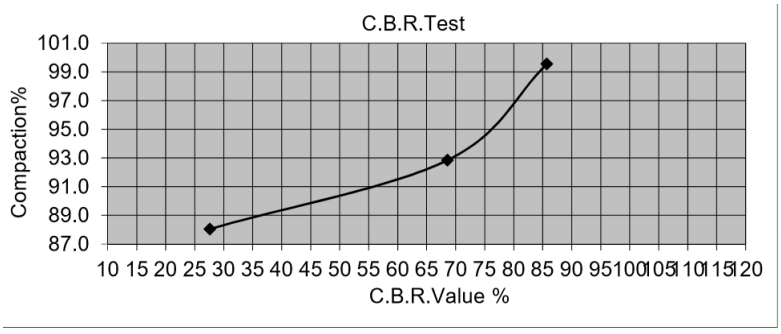




Corrected CBR at 2.5mm Penetration:
43 /70*100= **61.4** %
Corrected CBR at 5 mm Penetration:
90 /105*100 = **85.7** %
:. CBR = **85.7** %
Compaction = **99.5** %

Corrected CBR at 2.5mm Penetration:
40.0 /70*100= **57.1** %
Corrected CBR at 5 mm Penetration:
72 /105*100 = **68.6** %
:. CBR = **68.6** %
Compaction = **92.8** %

Corrected CBR at 2.5mm Penetration:
13.0 /70*100= **18.6** %
Corrected CBR at 2.5mm Penetration:
29 /105*100 = **27.6** %
:. CBR = **27.6** %
Compaction = **88.0** %



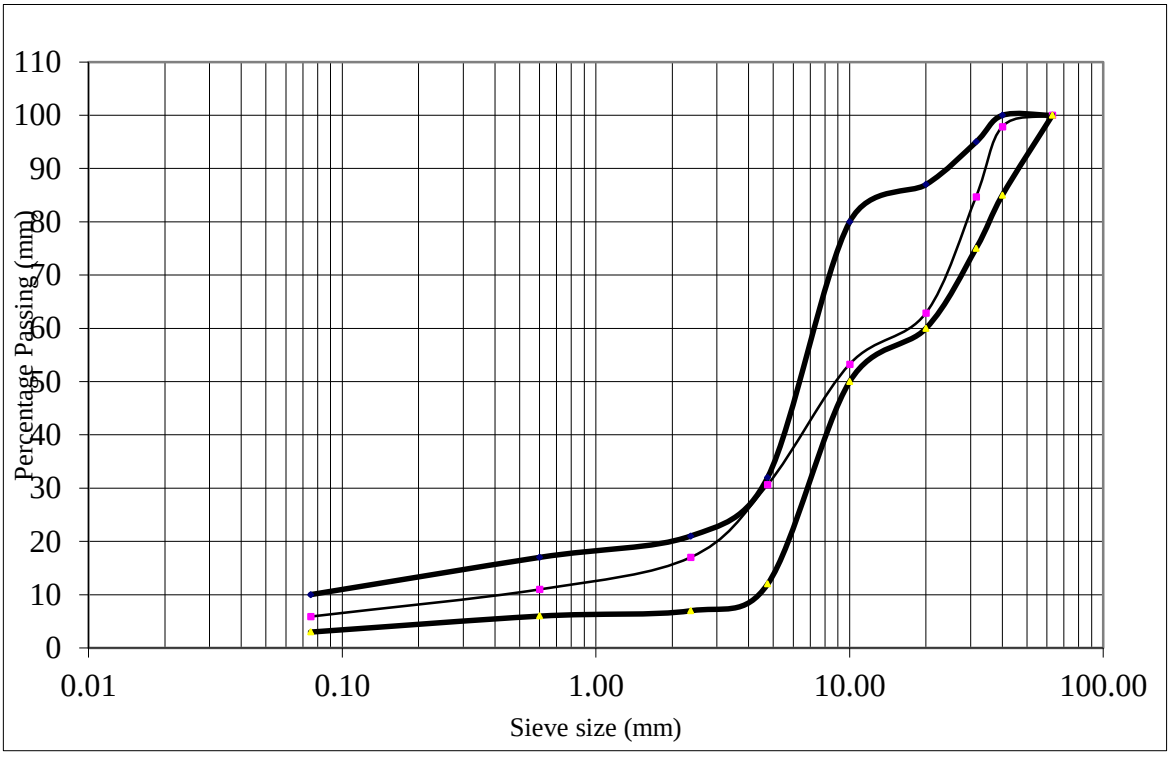
Test Result

:. C.B.R at 95% compaction= 76 %

APPENDIX 4 LAB TESTS RESULTS OF SUB- BASE OF BHYAKUR KHOLA QUARRY

1. Sieve Analysis of Sub Base (Bhyakure Khola)

Sieve Size (mm)	Specification		Weight Retained (g)	Weight Passing (g)	% Passing
	Lower Limit	Upper Limit			
63.00	100.00	100.00	0.0	14829.0	**100.0**
40.00	85.00	100.00	320.0	14509.0	**97.8**
31.50	75.00	95.00	1954.0	12555.0	**84.7**
20.00	60.00	87.00	3232.0	9323.0	**62.9**
10.00	50.00	80.00	1424.0	7899.0	**53.3**
4.75	12.00	32.00	3354.0	4545.0	**30.6**
Pan			4545.0		
Total			14829.0		
2.36	7.00	21.00	254.0	317.0	**17.0**
0.60	6.00	17.00	112.0	205.0	**11.0**
0.075	3.00	10.00	95.0	110.0	**5.9**
Pan			110.0	0.0	**0.0**
Rep. Total			**571.0**		



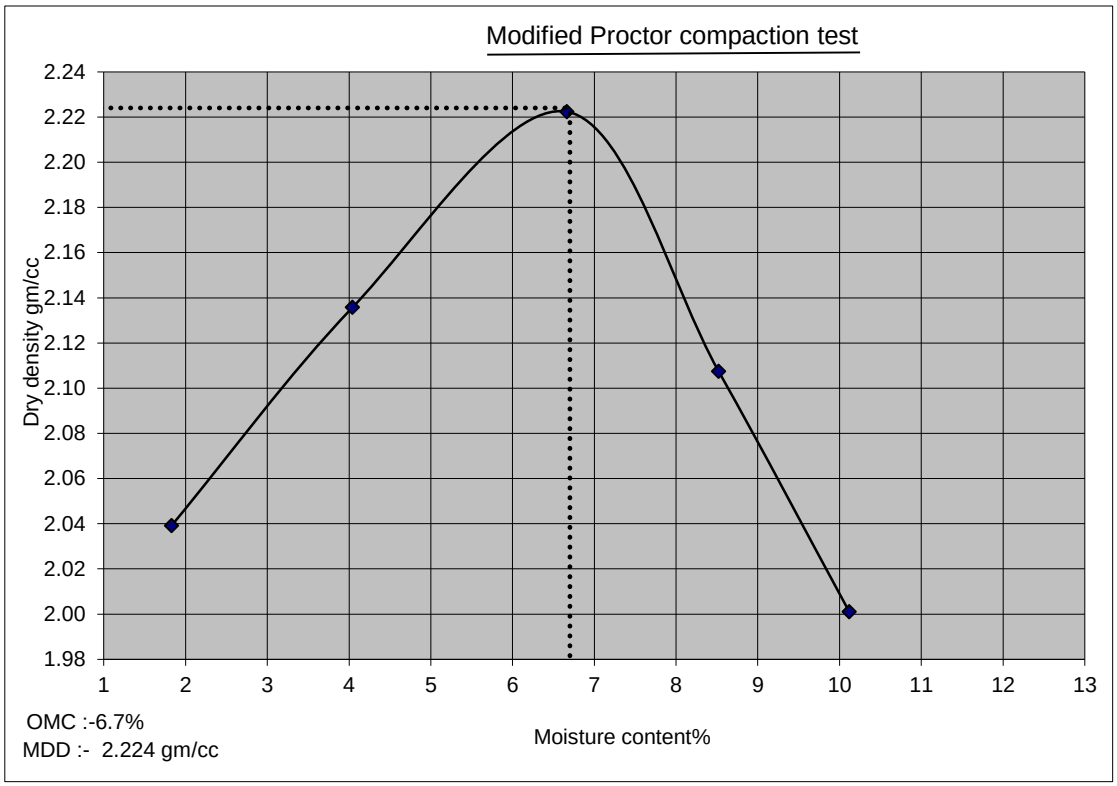
2. Modified Proctor Test of Sub Base (Bhyakure Khola)

Density

Test No.	1	2	3	4	5	6
Cylinder+ Soil (g)	10286	10614	10948	10760	10572	
Cylinder (g)	5612	5612	5612	5612	5612	
Wet Soil (g)	4674	5002	5336	5148	4960	
Wet density(g/cc)	2.076	2.222	2.371	2.287	2.203	

Moisture content

Container No.	3	B	3G	A 6	M	
Wt. of Wet soil+ can(g)	1079.6	1132.2	958.6	1104.5	1074.6	
Wt. of Dry soil+ can(g)	1067.8	1105.0	926.0	1051.8	1014.0	
Wt. Can (g)	422.3	432.2	436.9	433.2	415.0	
Wt. of Dry soil (g)	645.5	672.8	489.1	618.6	599	
Et. Of Moisture (g)	11.8	27.2	32.6	52.7	60.6	
Moisture content (%)	1.83	4.04	6.67	8.52	10.12	
Dry density(g/cc)	**2.039**	**2.136**	**2.222**	**2.107**	**2.001**	



3. CBR of Sub Base (Bhyakur Khola)

Test condition	Before Soaking			After Soaking		
Mould No.	C	M	A	C	M	A
No. of Blows per layer	60	30	10	60	30	10
Wt. of wet Sample + Mould (g)	12244.00	12430.00	12046.00	12276.00	12532.00	12193.00
Wt. of mould (g)	7026.00	7466.00	7396.00	7026.00	7466.00	7396.00
Wt. of wet sample (g)	5218.00	4964.00	4650.00	5250.00	5066.00	4797.00
Volume of mould (cc)	2216.00	2185.40	2188.37	2216.00	2185.40	2188.37
Wet density (g/cc)	2.355	2.271	2.125	2.369	2.318	2.192
Av. Moisture content (%)	6.77	6.86	6.46	7.60	8.12	8.68
Dry unit weight (g/cc)	2.205	2.126	1.996	2.202	2.144	2.017
MDD (g/cc)	2.224	2.224	2.224			
Compaction (%)	99.2	95.6	89.7			
Swelling				-	-	-
Water absorption (%)				0.61	2.05	3.16

Moisture Content Determination												
Test condition	Before Soaking						After Soaking					
Mould No.	C		M		A		C		M		A	
Can no.	1	2	3	4	5	6	1	2	3	4	5	6
Wt. of can + Wet soil (g)	930.4	912.6	947.5	913.4	867.5	913.8	813.9	912.9	970.5	876.0	948.3	957.5
Wt. of can + dry soil (g)	899.8	880.9	914.3	883.5	840.3	885.0	786.4	879.1	931.1	841.8	904.8	915.4
Wt. of water (g)	30.6	31.7	33.2	29.9	27.2	28.8	27.5	33.8	39.4	34.2	43.5	42.1
Wt. of empty can (g)	439.3	421.3	436.0	442.9	415.1	443.0	420.3	439.8	437.2	427.5	429.5	402.6
Wt. of dry soil (g)	460.5	459.6	478.3	440.6	425.2	442.0	366.1	439.3	493.9	414.3	475.3	512.8
Moisture content %	6.64	6.90	6.94	6.79	6.40	6.52	7.51	7.69	7.98	8.25	9.15	8.21
Av. Moisture content %	6.77		6.86		6.46		7.60		8.12		8.68	

CBR Test Data for Sub Base Course

Material Type : Sub Base
Location : Kalo dhunga (Bhyakur khola), Roshi - 11, Kavre

Penetration Test (60 blows)

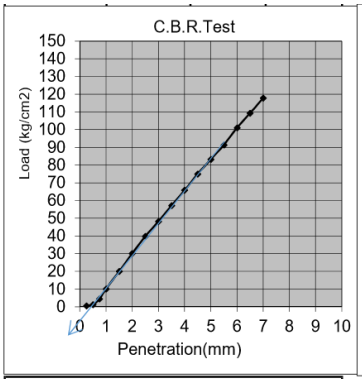
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	11.3	19.6	**0.6**
0.50	26.4	19.6	**1.3**
0.75	88.9	19.6	**4.5**
1.00	198.4	19.6	**10.1**
1.50	392.3	19.6	**20.0**
2.00	591.2	19.6	**30.2**
2.50	780.5	19.6	**39.8**
3.00	945	19.6	**48.2**
3.50	1120	19.6	**57.1**
4.00	1290	19.6	**65.8**
4.50	1470	19.6	**75.0**
5.00	1632	19.6	**83.3**
5.50	1792	19.6	**91.4**
6.00	1981	19.6	**101.1**
6.50	2143	19.6	**109.3**
7.00	2311	19.6	**117.9**

Penetration Test (30 blows)

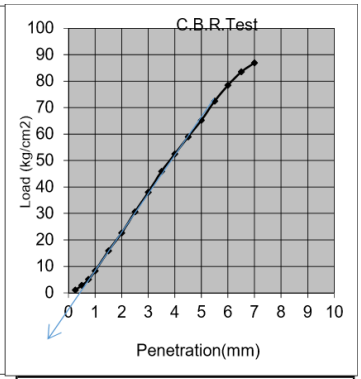
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	20	19.6	**1.0**
0.50	55	19.6	**2.8**
0.75	99	19.6	**5.1**
1.00	162	19.6	**8.3**
1.50	312	19.6	**15.9**
2.00	444	19.6	**22.7**
2.50	600	19.6	**30.6**
3.00	745	19.6	**38.0**
3.50	900	19.6	**45.9**
4.00	1028	19.6	**52.4**
4.50	1155.4	19.6	**58.9**
5.00	1278.9	19.6	**65.3**
5.50	1420.3	19.6	**72.5**
6.00	1537.6	19.6	**78.4**
6.50	1636.3	19.6	**83.5**
7.00	1703.6	19.6	**86.9**

Penetration Test (10 blows)

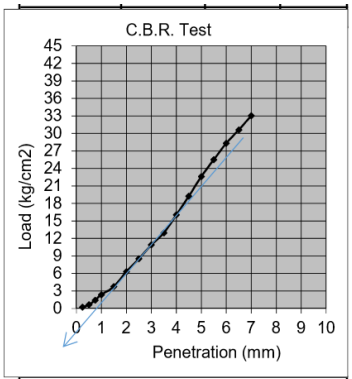
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	4.4	19.6	**0.2**
0.50	12.3	19.6	**0.6**
0.75	27.5	19.6	**1.4**
1.00	46.4	19.6	**2.4**
1.50	73.6	19.6	**3.8**
2.00	123.5	19.6	**6.3**
2.50	166.7	19.6	**8.5**
3.00	213.5	19.6	**10.9**
3.50	254.1	19.6	**13.0**
4.00	314.3	19.6	**16.0**
4.50	377	19.6	**19.2**
5.00	443	19.6	**22.6**
5.50	500	19.6	**25.5**
6.00	555	19.6	**28.3**
6.50	600	19.6	**30.6**
7.00	647.1	19.6	**33.0**



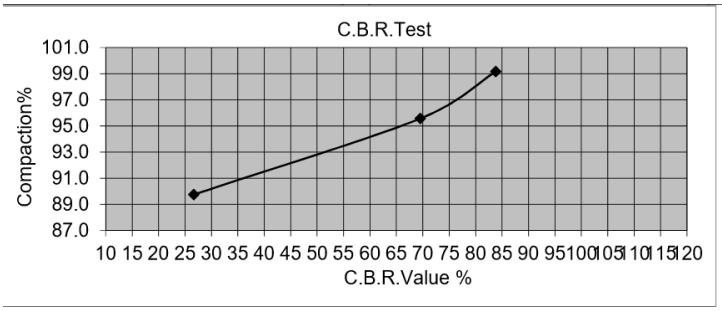
Corrected CBR at 2.5mm Penetration:
46 **/70*100= 65.7** %
Corrected CBR at 5 mm Penetration:
88 /105*100 = 83.8 %
:. CBR = **83.8** %
Compaction = **99.2** %



Corrected CBR at 2.5mm Penetration:
35.0 /70*100= 50.0 %
Corrected CBR at 5 mm Penetration:
73 /105*100 = 69.5 %
:. CBR = **69.5** %
Compaction = **95.6** %



Corrected CBR at 2.5mm Penetration:
13.0 /70*100= 18.6 %
Corrected CBR at 2.5mm Penetration:
28 /105*100 = 26.7 %
:. CBR = **26.7** %
Compaction = **89.7** %



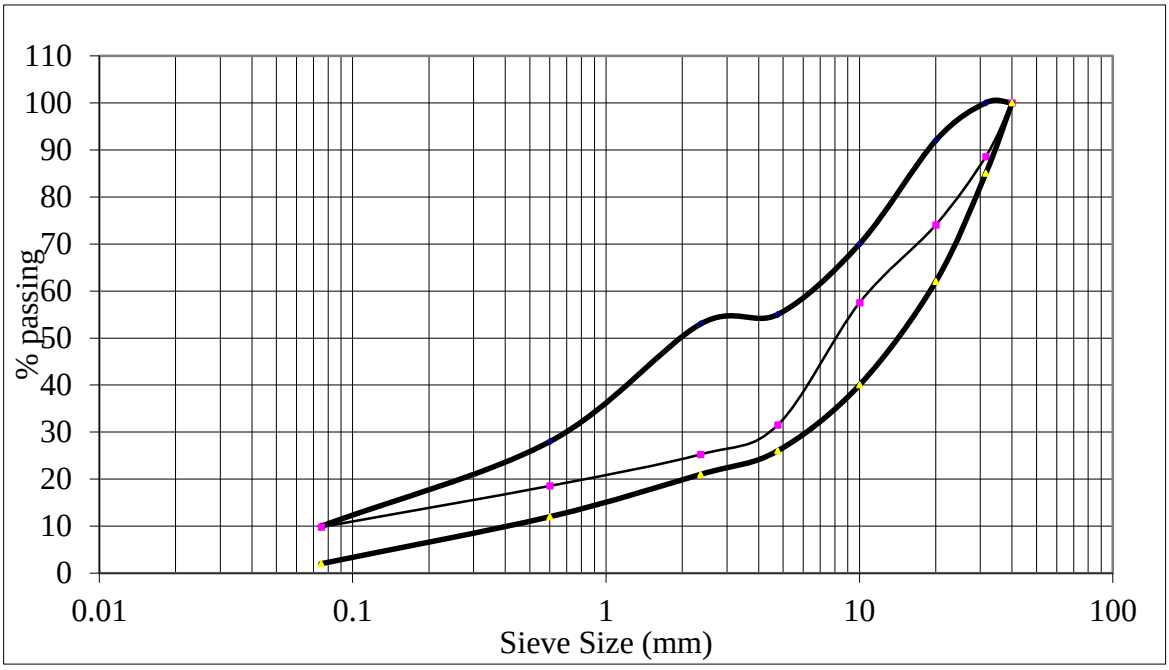
Test Result

:. C.B.R at 95% compaction= 68 %

APPENDIX 5 LAB TESTS RESULTS OF BASE OF CHALAAL GANESH QUARRY

1. Sieve Analysis of Base (Chalaal Ganesh)

Sieve Size (mm)	Specification		Weight Retained (g)	Weight Passing (g)	% Passing
	Lower Limit	Upper Limit			
40.00	100.00	100.00	0.0	17670.0	**100.0**
31.50	85.00	100.00	2021.0	15649.0	**88.6**
20.00	62.00	92.00	2565.0	13084.0	**74.0**
10.00	40.00	70.00	2922.0	10162.0	**57.5**
4.75	26.00	55.00	4596.0	5566.0	**31.5**
Pan			5566.0		
Total			17670.0		
2.36	21.00	53.00	134.2	546.3	**25.3**
0.60	12.00	28.00	144.6	401.7	**18.6**
0.08	2.00	10.00	189.3	212.4	**9.8**
Pan			212.4	0.0	**0.0**
Rep. Total			**680.5**		



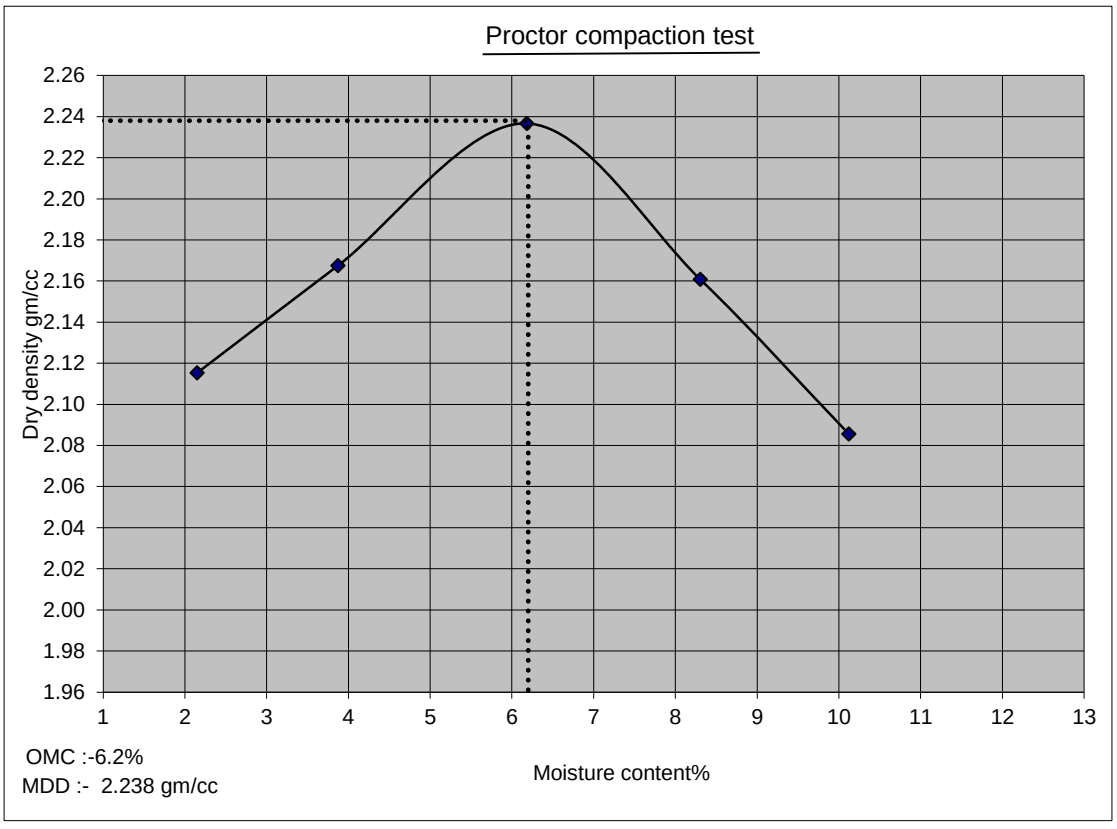
2. Modified Proctor Compaction Test of Base (Chalaal Ganeshsthan)

Density

Test No.	**1**	**2**	**3**	**4**	**5**
Cylinder+ Soil (g)	10476	10680	10958	10880	10782
Cylinder (g)	5612	5612	5612	5612	5612
Wet Soil (g)	4864	5068	5346	5268	5170
Wet density(g/cc)	**2.161**	**2.251**	**2.375**	**2.340**	**2.297**

Moisture content

Container No.	Mo	4	mk	3G	Q
Wt. of Wet soil+ can(g)	1075.8	1132.2	954.8	1098.5	1070.5
Wt. of Dry soil+ can(g)	1062.0	1106.0	924.6	1047.8	1011.4
Wt. Can (g)	420.3	429.5	436.0	437.2	427.5
Wt. of Dry soil (g)	**641.7**	**676.5**	**488.6**	**610.6**	**583.9**
Et. Of Moisture (g)	**13.8**	**26.2**	**30.2**	**50.7**	**59.1**
Moisture content (%)	**2.15**	**3.87**	**6.18**	**8.30**	**10.12**
Dry density(g/cc)	**2.115**	**2.167**	**2.237**	**2.161**	**2.086**



3. CBR Test of Base (Chalaal Ganeshthan)

Test condition	Before Soaking			After Soaking		
Mould No.	C	M	A	C	M	A
No. of Blows per layer	60	30	10	60	30	10
Wt. of wet Sample + Mould (g)	12380.00	12230.00	11782.00	12410.00	12275.00	11835.00
Wt. of mould (g)	7026.00	7466.00	7396.00	7026.00	7466.00	7396.00
Wt. of wet sample (g)	5354.00	4764.00	4386.00	5384.00	4809.00	4439.00
Volume of mould (cc)	2216.00	2185.40	2188.37	2216.00	2185.40	2188.37
Wet density (g/cc)	2.416	2.180	2.004	2.430	2.201	2.028
Av. Moisture content (%)	6.22	6.35	6.42	7.17	7.63	8.12
Dry unit weight (g/cc)	2.274	2.050	1.883	2.267	2.044	1.876
MDD (g/cc)	2.238	2.238	2.238			
Compaction (%)	101.6	91.6	84.1			
Swelling				-	-	-
Water absorption (%)				0.56	0.94	1.21

Moisture Content Determination												
Test condition	Before Soaking						After Soaking					
Mould No.	C		M		A		C		M		A	
Can no.	1	2	3	4	5	6	1	2	3	4	5	6
Wt. of can + Wet soil (g)	939.3	830.2	788.4	974.5	887.6	798.5	912.5	893.4	945.8	894.9	947.5	870.6
Wt. of can + dry soil (g)	909.3	807.8	765.5	941.6	861.6	774.1	881.2	862.6	907.8	861.3	910.2	835.2
Wt. of water (g)	30.0	22.4	22.9	32.9	26.0	24.4	31.3	30.8	38.0	33.6	37.3	35.4
Wt. of empty can (g)	439.4	438.4	402.6	427.4	448.3	401.9	439.5	438.4	402.7	427.3	448.3	401.8
Wt. of dry soil (g)	469.9	369.4	362.9	514.2	413.3	372.2	441.7	424.2	505.1	434.0	461.9	433.4
Moisture content %	6.38	6.06	6.31	6.40	6.29	6.56	7.09	7.26	7.52	7.74	8.08	8.17
Av. Moisture content %	6.22		6.35		6.42		7.17		7.63		8.12	

CBR Test Data for Base Course

Material Type : Base
Location : Bethanchowk -4, Kavre (Chalal Ganeshthan)

Penetration Test (60 blows)

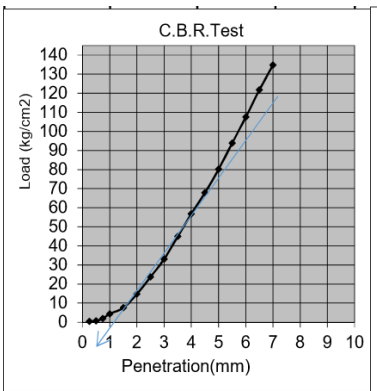
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	8.6	19.6	**0.4**
0.50	14.3	19.6	**0.7**
0.75	38.1	19.6	**1.9**
1.00	86.3	19.6	**4.4**
1.50	148.0	19.6	**7.6**
2.00	289.9	19.6	**14.8**
2.50	465.9	19.6	**23.8**
3.00	648.5	19.6	**33.1**
3.50	881.0	19.6	**44.9**
4.00	1113.2	19.6	**56.8**
4.50	1330.0	19.6	**67.9**
5.00	1571.2	19.6	**80.2**
5.50	1840.0	19.6	**93.9**
6.00	2107.0	19.6	**107.5**
6.50	2387.0	19.6	**121.8**
7.00	2642.0	19.6	**134.8**

Penetration Test (30 blows)

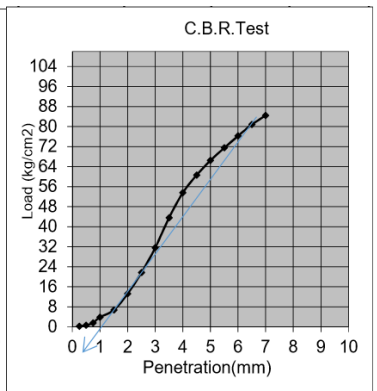
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	4.5	19.6	**0.2**
0.50	12.3	19.6	**0.6**
0.75	31.3	19.6	**1.6**
1.00	76.0	19.6	**3.9**
1.50	132.0	19.6	**6.7**
2.00	260.0	19.6	**13.3**
2.50	425.0	19.6	**21.7**
3.00	620.5	19.6	**31.7**
3.50	854.6	19.6	**43.6**
4.00	1050.2	19.6	**53.6**
4.50	1188.6	19.6	**60.6**
5.00	1303.0	19.6	**66.5**
5.50	1402.0	19.6	**71.5**
6.00	1495.0	19.6	**76.3**
6.50	1585.0	19.6	**80.9**
7.00	1655.0	19.6	**84.4**
7.50			
8.00			
8.50			

Penetration Test (10 blows)

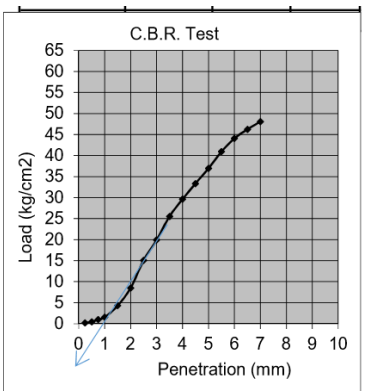
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	4.0	19.6	**0.2**
0.50	8.3	19.6	**0.4**
0.75	20.0	19.6	**1.0**
1.00	30.1	19.6	**1.5**
1.50	84.2	19.6	**4.3**
2.00	166.5	19.6	**8.5**
2.50	295.4	19.6	**15.1**
3.00	390.4	19.6	**19.9**
3.50	500.4	19.6	**25.5**
4.00	580.4	19.6	**29.6**
4.50	653.4	19.6	**33.3**
5.00	724.2	19.6	**36.9**
5.50	802.3	19.6	**40.9**
6.00	863.6	19.6	**44.1**
6.50	906.3	19.6	**46.2**
7.00	942.5	19.6	**48.1**



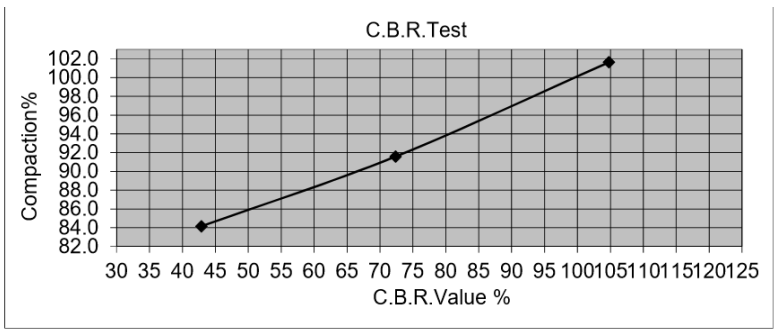
Corrected CBR at 2.5mm Penetration:
50 /70*100= **71.4** %
Corrected CBR at 5 mm Penetration:
110 /105*100 = **104.8** %
:. CBR = **104.8** %
Compaction = **101.6** %



Corrected CBR at 2.5mm Penetration:
45.0 /70*100= **64.3** %
Corrected CBR at 5 mm Penetration:
76 /105*100 = **72.4** %
:. CBR = **72.4** %
Compaction = **91.6** %



Corrected CBR at 2.5mm Penetration:
25.0 /70*100= **35.7** %
Corrected CBR at 5 mm Penetration:
45 /105*100 = **42.9** %
:. CBR = **42.9** %
Compaction = **84.1** %



Test Result

:. C.B.R at 98% compaction= 93 %

4. LAA and AIV

Los Angeles Abrasion (LAA) Test of Base Course

Location : Bethanchowk -4, Kavre (Chalaal Ganeshthan)
Grading : A No. of spheres used : 12

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of sample W1 (g)	5000	5000	
2	Wt. of sample retained on 1.70 mm seive after abrasion test W2 (g)	3113	3079	
3	Weight of loss (W1-W2) W3(g)	1887	1921	
4	LAA value (W3/W1*100) %	37.74	38.42	
5	Average LAA value (%)	38.08		

Aggregate Impact Value (AIV) Test of Base Course

Location : Bethanchowk -4, Kavre (Chalaal Ganeshthan)

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of measure + Compacted sample W1 (g)	1234.5	1216.7	
2	Wt. of cylindrical measures W2(g)	915.4	915.4	
3	Wt. of compacted sample W3(=W1-W2) g	319.1	301.3	
4	Wt. of sample passing on 2.36 mm sieve after test W4 (g)	92.4	81.3	
4	AIV= (W4/W3*100) %	28.96	26.98	
5	Average AIV (%)	27.97		

5. FI/ EI and CR value

Combined Flakiness & Elongation Index of Base course

Location : Bethanchowk -4, Kavre (Chalaal Ganeshthan)

Flakiness plate Slot size Identification (mm)	Wt. retained on flakiness plate (g)	Wt. passing slot on flakiness plate (g)	Total weight tested for Flakiness (g)	Total Wt. tested for Elongation (Retained on flakiness plate) (g)	Wt. retained on Length gauge (g)
C	D	E	F=D+E	D	G
40 to 25	1698	412	2110	1698	197
25 to 19	1260	287	1547	1260	142
19 to 16	870	242	1112	870	123
16 to 12.5	636	190	826	636	102
12.5 to 9.5	492	124	616	492	76
9.5 to 6.3	312	108	420	312	67
Total	5268	1363	6631	5268	707

Flakiness Index, FI (%) =	*E/F *100 % =*	*20.55*
Elongation Index, EI (%) =	*G/D *100% =*	*13.42*
Combined FI + EI (%) =		**33.98**

Crushing Ratio (CR) Test of Base Course

Location : Bethanchowk -4, Kavre (Chalaal Ganeshthan)

S.N.	Description	Test Number		Remarks
		1	2	
1	Total wt. of Aggregate sample, W1 (g)	2458	2510	
2	Total wt. of crushed aggregates, W2 (g)	2270	2348	
4	Crushing ratio (CR) = W2/W1 *100 %	92.35	93.55	
5	Average Crushing ratio (CR)	92.95		

6. Specific Gravity and Water Absorption

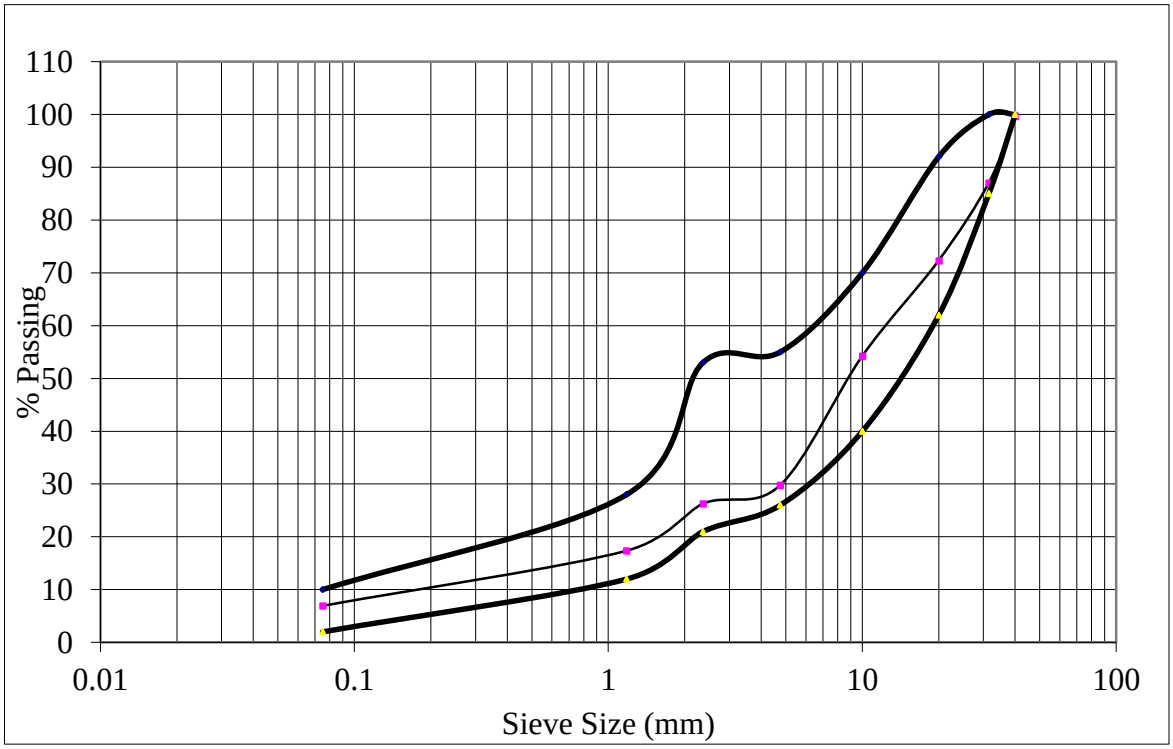
Location : Bethanchowk -4, Kavre (Chalal Ganeshthan)
Material : Base

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+Saturated, Surface Dry Sample	B1	2340.2
2	Wt. Pan	B2	420.1
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	1920.1
4	Wt. Basket + Sample in Water	C1	1753.0
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1205.3
7	Wt. of Oven Dry Sample	A	1903.9
	Bulk G (Oven Dry) = A/(B-C)		2.664
	Bulk G (SSD) = B/(B-C)		2.686
	Apparent G = A/(A-C)		2.725
	Absorption=[(B-A)/A]*100%		0.85%

APPENDIX 6 LAB TESTS RESULTS OF BASE OF GHYAMPE KHOLA (AAPGHARI) QUARRY

1. Sieve Analysis of Base (Ghyampe Khola)

Sieve Size (mm)	Specification		Weight Retained (g)	Weight Passing (g)	% Passing
	Lower Limit	Upper Limit			
40.00	100.00	100.00	75.0	20049.0	**99.6**
31.50	85.00	100.00	2541.0	17508.0	**87.0**
20.00	62.00	92.00	2954.0	14554.0	**72.3**
10.00	40.00	70.00	3643.0	10911.0	**54.2**
4.75	26.00	55.00	4919.0	5992.0	**29.8**
Pan			5992.0		
Total			**20124.0**		
2.36	21.00	53.00	100.6	756.9	**26.3**
1.18	12.00	28.00	256.3	500.6	**17.4**
0.075	2.00	10.00	300.5	200.1	**6.9**
Pan			200.1	0.0	**0.0**
Rep. Total			**857.5**		



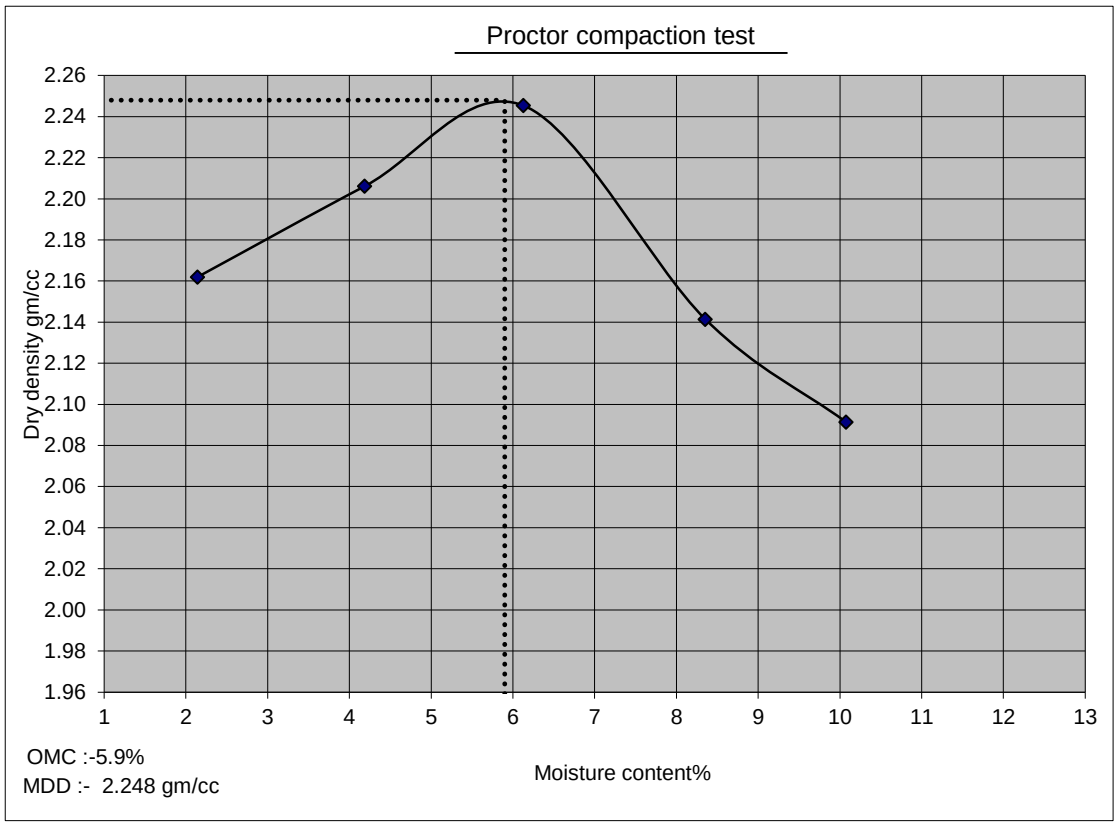
2. Modified Proctor Test of Base (Ghyampe Khola)

Density

Test No.	**1**	**2**	**3**	**4**	**5**
Cylinder+ Soil (g)	10583	10786	10976	10835	10794
Cylinder (g)	5612	5612	5612	5612	5612
Wet Soil (g)	4971	5174	5364	5223	5182
Wet density(g/cc)	**2.208**	**2.299**	**2.383**	**2.320**	**2.302**

Moisture content

Container No.	7	MO	A	5D	Mk
Wt. of Wet soil+ can(g)	978.8	948.2	976.4	936.2	890.5
Wt. of Dry soil+ can(g)	966.7	927.0	945.6	897.9	848.9
Wt. Can (g)	402.6	420.9	443.0	439.4	436.0
Wt. of Dry soil (g)	**564.1**	**506.1**	**502.6**	**458.5**	**412.9**
Et. Of Moisture (g)	**12.1**	**21.2**	**30.8**	**38.3**	**41.6**
Moisture content (%)	**2.15**	**4.19**	**6.13**	**8.35**	**10.08**
Dry density(g/cc)	**2.162**	**2.206**	**2.245**	**2.141**	**2.091**



3. CBR of Base (Ghyampe Khola)

Test condition	Before Soaking			After Soaking		
Mould No.	C	M	A	C	M	A
No. of Blows per layer	60	30	10	60	30	10
Wt. of wet Sample + Mould (g)	12334.00	12523.00	12257.00	12367.00	12584.00	12346.00
Wt. of mould (g)	7026.00	7466.00	7396.00	7026.00	7466.00	7396.00
Wt. of wet sample (g)	5308.00	5057.00	4861.00	5341.00	5118.00	4950.00
Volume of mould (cc)	2216.00	2185.40	2188.37	2216.00	2185.40	2188.37
Wet density (g/cc)	2.395	2.314	2.221	2.410	2.342	2.262
Av. Moisture content (%)	6.10	6.30	5.92	6.88	7.84	8.54
Dry unit weight (g/cc)	2.258	2.177	2.097	2.255	2.172	2.084
MDD (g/cc)	2.238	2.238	2.238			
Compaction (%)	100.9	97.3	93.7			
Swelling				-	-	-
Water absorption (%)				0.62	1.21	1.83

Moisture Content Determination												
Test condition	Before Soaking						After Soaking					
Mould No.	C		M		A		C		M		A	
Can no.	1	2	3	4	5	6	1	2	3	4	5	6
Wt. of can + Wet soil (g)	958.5	935.2	942.3	1042.4	976.2	830.2	912.5	893.4	945.8	894.9	947.5	870.6
Wt. of can + dry soil (g)	926.1	907.3	911.2	1006.2	945.6	808.3	880.2	864.2	908.8	861.3	906.7	836.4
Wt. of water (g)	32.4	27.9	31.1	36.2	30.6	21.9	32.3	29.2	37.0	33.6	40.8	34.2
Wt. of empty can (g)	402.6	443.0	420.4	427.4	421.3	443.0	415.0	436.1	439.8	429.6	427.5	437.3
Wt. of dry soil (g)	523.5	464.3	490.8	578.8	524.3	365.3	465.2	428.1	469.0	431.7	479.2	399.1
Moisture content %	6.19	6.01	6.34	6.25	5.84	6.00	6.94	6.82	7.89	7.78	8.51	8.57
Av. Moisture content %	6.10		6.30		5.92		6.88		7.84		8.54	

CBR Test Data for Base Course

Material Type : Base
Location : Aapghari

Penetration Test (60 blows)

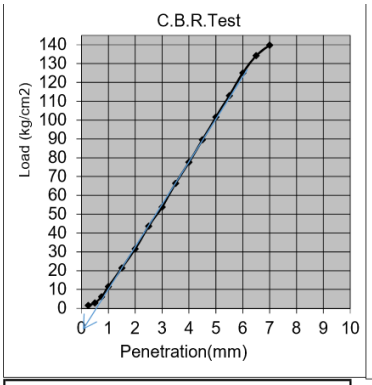
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	30.3	19.6	**1.5**
0.50	57.1	19.6	**2.9**
0.75	120.5	19.6	**6.1**
1.00	225.0	19.6	**11.5**
1.50	420.1	19.6	**21.4**
2.00	620.3	19.6	**31.6**
2.50	855.5	19.6	**43.6**
3.00	1055.7	19.6	**53.9**
3.50	1300.9	19.6	**66.4**
4.00	1520.4	19.6	**77.6**
4.50	1755.3	19.6	**89.6**
5.00	1990.6	19.6	**101.6**
5.50	2215.2	19.6	**113.0**
6.00	2450.6	19.6	**125.0**
6.50	2630.9	19.6	**134.2**
7.00	2740.5	19.6	**139.8**

Penetration Test (30 blows)

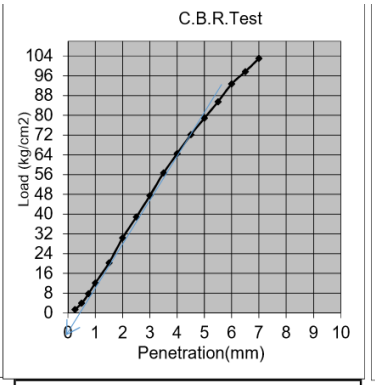
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	26.7	19.6	**1.4**
0.50	76.4	19.6	**3.9**
0.75	152.1	19.6	**7.8**
1.00	236.9	19.6	**12.1**
1.50	397.4	19.6	**20.3**
2.00	594.6	19.6	**30.3**
2.50	760.5	19.6	**38.8**
3.00	930.4	19.6	**47.5**
3.50	1110.3	19.6	**56.6**
4.00	1264.2	19.6	**64.5**
4.50	1414.4	19.6	**72.2**
5.00	1545.6	19.6	**78.9**
5.50	1676.3	19.6	**85.5**
6.00	1816.9	19.6	**92.7**
6.50	1915.1	19.6	**97.7**
7.00	2018.7	19.6	**103.0**

Penetration Test (10 blows)

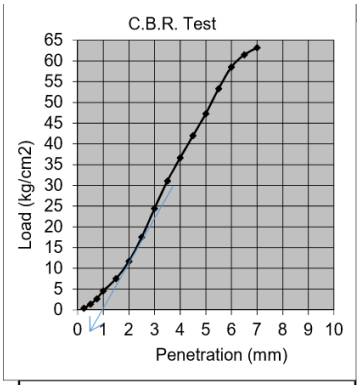
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	7.1	19.6	**0.4**
0.50	27.3	19.6	**1.4**
0.75	52.4	19.6	**2.7**
1.00	88.9	19.6	**4.5**
1.50	147.5	19.6	**7.5**
2.00	229.3	19.6	**11.7**
2.50	343.3	19.6	**17.5**
3.00	478.7	19.6	**24.4**
3.50	608.5	19.6	**31.0**
4.00	718.3	19.6	**36.6**
4.50	823.1	19.6	**42.0**
5.00	926.9	19.6	**47.3**
5.50	1045.0	19.6	**53.3**
6.00	1147.4	19.6	**58.5**
6.50	1205.2	19.6	**61.5**
7.00	1238.1	19.6	**63.2**



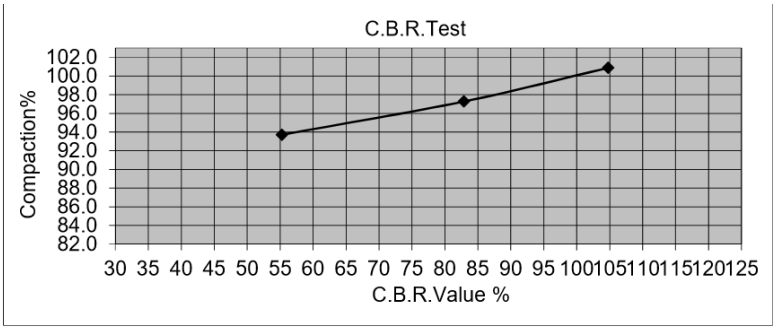
Corrected CBR at 2.5mm Penetration:
50 **/70*100= 71.4** %
Corrected CBR at 5 mm Penetration:
110 /105*100 = 104.8 %
:. CBR = **104.8** %
Compaction = **100.9** %



Corrected CBR at 2.5mm Penetration:
44.0 /70*100= 62.9 %
Corrected CBR at 5 mm Penetration:
87 /105*100 = 82.9 %
:. CBR = **82.9** %
Compaction = **97.3** %



Corrected CBR at 2.5mm Penetration:
30.0 /70*100= 42.9 %
Corrected CBR at 5 mm Penetration:
58 /105*100 = 55.2 %
:. CBR = **55.2** %
Compaction = **93.7** %



Test Result

:. C.B.R at 98% compaction= 84 %

4. LAA and AIV

Los Angeles Abrasion (LAA) Test of Base Course

Location : Sunkoshi -1, Sindhuli ,Ghyampe Khola (Aapghari)
Grading : A No. of spheres used : 12

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of sample W1 (g)	5000	5000	
2	Wt. of sample retained on 1.70 mm seive after abrasion test W2 (g)	3476	3481	
3	Weight of loss (W1-W2) W3(g)	1524	1519	
4	LAA value (W3/W1*100) %	30.48	30.38	
5	Average LAA value (%)	30.43		

Aggregate Impact Value (AIV) Test of Base Course

Location : Sunkoshi -1, Sindhuli ,Ghyampe Khola (Aapghari)

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of measure + Compacted sample W1 (g)	1234.5	1263.3	
2	Wt. of cylindrical measures W2(g)	915.4	915.4	
3	Wt. of compacted sample W3(=W1-W2) g	319.1	347.9	
4	Wt. of sample passing on 2.36 mm sieve after test W4 (g)	63.2	68.5	
4	AIV= (W4/W3*100) %	19.81	19.69	
5	Average AIV (%)	19.75		

5. FI/ EI and CR value

Combined Flakiness & Elongation Index of Base course

Location : Sunkoshi -1, Sindhuli ,Ghyampe Khola (Aapghari)

Flakiness plate Slot size Identification (mm)	Wt. retained on flakiness plate (g)	Wt. passing slot on flakiness plate (g)	Total weight tested for Flakiness (g)	Total Wt. tested for Elongation (Retained on flakiness plate) (g)	Wt. retained on Length gauge (g)
C	D	E	F=D+E	D	G
40 to 25	1722	207	1929	1722	187
25 to 19	926	140	1066	926	135
20 to 16	740	192	932	740	134
16 to 12.5	538	143	681	538	107
12.5 to 9.5	395	124	519	395	65
9.5 to 6.3	326	108	434	326	39
Total	4647	914	5561	4647	667

Flakiness Index, FI (%) =	*E/F *100 % =*	*16.44*
Elongation Index, EI (%) =	*G/D *100% =*	*14.35*
Combined FI + EI (%) =		**30.79**

Crushing Ratio (CR) Test of Base Course

Location : Sunkoshi -1, Sindhuli ,Ghyampe Khola (Aapghari)

S.N.	Description	Test Number		Remarks
		1	2	
1	Total wt. of Aggregate sample, W1 (g)	2341	2148	
2	Total wt. of crushed aggregates, W2 (g)	2067	1940	
4	Crushing ratio (CR) = W2/W1 *100 %	88.30	90.32	
5	Average Crushing ratio (CR)	89.31		

6. Specific Gravity and Water Absorption

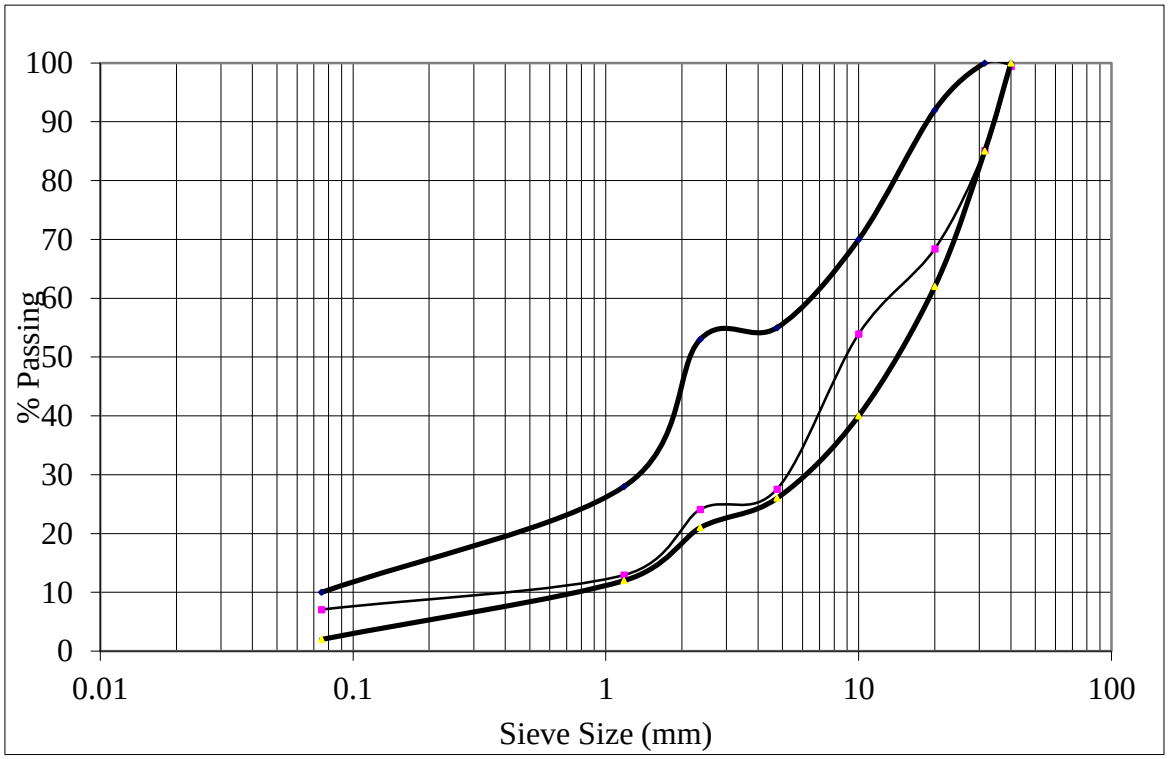
Location Ghyampa Khola (Aapghari)
Material: Base

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+Saturated, Surface Dry Sample	B1	2489.3
2	Wt. Pan	B2	429.2
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	2060.1
4	Wt. Basket + Sample in Water	C1	1836.2
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1288.5
7	Wt. of Oven Dry Sample	A	2049.3
	Bulk G (Oven Dry) = A/(B-C)		2.65591
	Bulk G (SSD) = B/(B-C)		2.669907
	Apparent G = A/(A-C)		2.693612
	Absorption=[(B-A)/A]*100%		0.53%

APPENDIX 7 LAB TESTS RESULTS OF BASE OF OM BUDDHA QUARRY

1. Sieve Analysis of Base (Om Buddha)

Sieve Size in mm	Specification		Weight Retained (g)	Weight Passing (g)	% Passing
	Lower Limit	Upper Limit			
40.00	100.00	100.00	105.0	18132.3	**99.4**
31.50	85.00	100.00	2610.0	15522.3	**85.1**
20.00	62.00	92.00	3045.0	12477.3	**68.4**
10.00	40.00	70.00	2640.0	9837.3	**53.9**
4.75	26.00	55.00	4812.3	5025.0	**27.6**
Pan			5025.0		
Total			**18237.3**		
2.36	21.00	53.00	85.5	597.9	**24.1**
1.18	12.00	28.00	276.7	321.2	**13.0**
0.075	2.00	10.00	145.6	175.6	**7.1**
Pan			175.6		
Rep. Total			**683.4**		



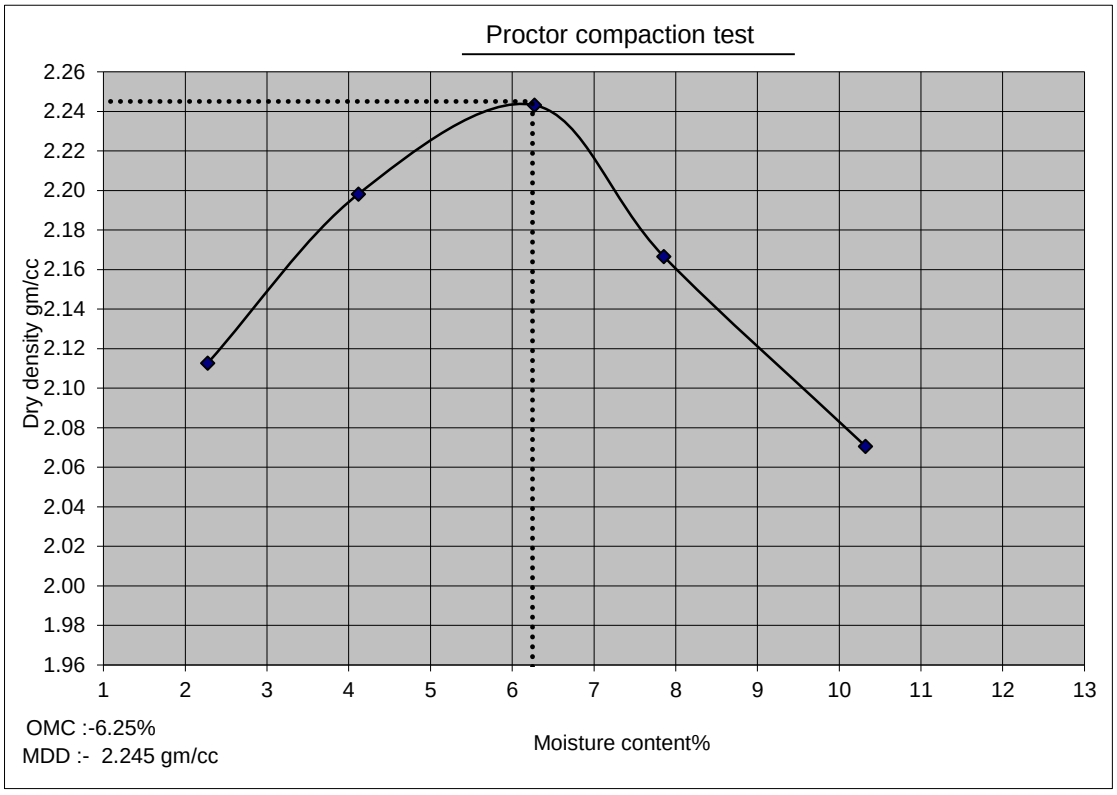
2. Modified Proctor Test of Base (Om Buddha)

Density

Test No.	**1**	**2**	**3**	**4**	**5**
Cylinder+ Soil (g)	10476	10764	10978	10872	10754
Cylinder (g)	5612	5612	5612	5612	5612
Wet Soil (g)	4864	5152	5366	5260	5142
Wet density(g/cc)	**2.161**	**2.289**	**2.384**	**2.337**	**2.284**

Moisture content

Container No.	C	A	MO	4	D
Wt. of Wet soil+ can(g)	924.6	976.2	1021.8	948.3	1039.2
Wt. of Dry soil+ can(g)	913.4	955.1	986.3	910.5	983.4
Wt. Can (g)	421.3	442.8	420.3	429.3	442.9
Wt. of Dry soil (g)	**492.1**	**512.3**	**566**	**481.2**	**540.5**
Et. Of Moisture (g)	**11.2**	**21.1**	**35.5**	**37.8**	**55.8**
Moisture content (%)	**2.28**	**4.12**	**6.27**	**7.86**	**10.32**
Dry density(g/cc)	**2.113**	**2.198**	**2.243**	**2.167**	**2.071**



3. CBR of Base (Om Buddha)

Test condition	Before Soaking			After Soaking		
Mould No.	C	M	A	C	M	A
No. of Blows per layer	60	30	10	60	30	10
Wt. of wet Sample + Mould (g)	12324.00	12447.00	11898.00	12362.00	12514.00	11979.00
Wt. of mould (g)	7026.00	7466.00	7396.00	7026.00	7466.00	7396.00
Wt. of wet sample (g)	5298.00	4981.00	4502.00	5336.00	5048.00	4583.00
Volume of mould (cc)	2216.00	2185.40	2188.37	2216.00	2185.40	2188.37
Wet density (g/cc)	2.391	2.279	2.057	2.408	2.310	2.094
Av. Moisture content (%)	6.41	6.37	6.23	7.26	7.87	8.34
Dry unit weight (g/cc)	2.247	2.143	1.937	2.245	2.141	1.933
MDD (g/cc)	2.245	2.245	2.245			
Compaction (%)	100.1	95.4	86.3			
Swelling				-	-	-
Water absorption (%)				0.72	1.35	1.80

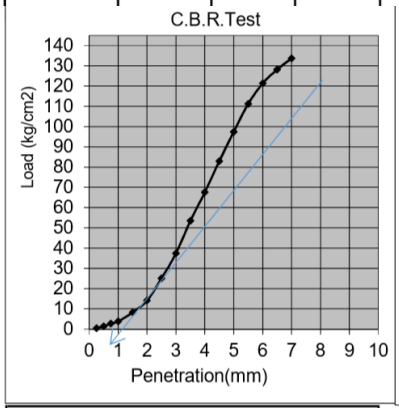
Moisture Content Determination												
Test condition	Before Soaking						After Soaking					
Mould No.	C		M		A		C		M		A	
Can no.	1	2	3	4	5	6	1	2	3	4	5	6
Wt. of can + Wet soil (g)	973.6	912.6	872.1	967.4	890.3	848.2	937.5	968.7	792.1	930.8	879.9	914.6
Wt. of can + dry soil (g)	942.3	883.1	843.9	935.2	862.2	823.8	903.1	930.2	763.4	895.3	842.9	878.2
Wt. of water (g)	31.3	29.5	28.2	32.2	28.1	24.4	34.4	38.5	28.7	35.5	37.0	36.4
Wt. of empty can (g)	448.3	427.5	402.6	427.4	402.6	439.6	427.3	401.8	402.7	439.5	402.6	438.4
Wt. of dry soil (g)	494.0	455.6	441.3	507.8	459.6	384.2	475.8	528.4	360.7	455.8	440.3	439.8
Moisture content %	6.34	6.47	6.39	6.34	6.11	6.35	7.23	7.29	7.96	7.79	8.40	8.28
Av. Moisture content %	6.41		6.37		6.23		7.26		7.87		8.34	

CBR Test Data for Base Course

Material Type : Base
Location : Sunkoshi -2 ,Kamere, Sindhuli (Om Buddha crusher)

Penetration Test (60 blows)

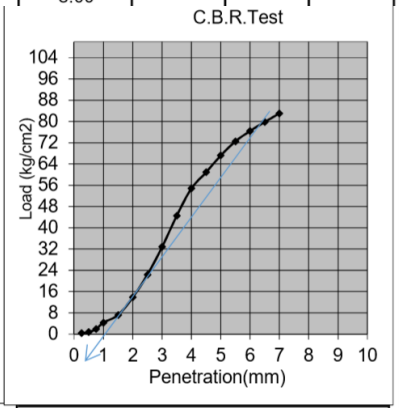
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	9.8	19.6	**0.5**
0.50	26.9	19.6	**1.4**
0.75	54.4	19.6	**2.8**
1.00	74.5	19.6	**3.8**
1.50	162.3	19.6	**8.3**
2.00	275.9	19.6	**14.1**
2.50	491.5	19.6	**25.1**
3.00	733.8	19.6	**37.4**
3.50	1048.2	19.6	**53.5**
4.00	1325.1	19.6	**67.6**
4.50	1626.2	19.6	**83.0**
5.00	1910.1	19.6	**97.5**
5.50	2180.0	19.6	**111.2**
6.00	2378.3	19.6	**121.3**
6.50	2512.2	19.6	**128.2**
7.00	2620.0	19.6	**133.7**



Corrected CBR at 2.5mm Penetration:
52 **/70*100= 74.3** %
Corrected CBR at 5 mm Penetration:
120 /105*100 = 114.3 %
:. CBR = **114.3** %
Compaction = **100.1** %

Penetration Test (30 blows)

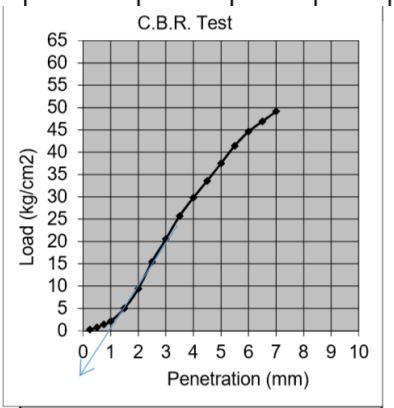
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	6.5	19.6	**0.3**
0.50	15.3	19.6	**0.8**
0.75	36.3	19.6	**1.9**
1.00	84.2	19.6	**4.3**
1.50	141.0	19.6	**7.2**
2.00	271.4	19.6	**13.8**
2.50	438.3	19.6	**22.4**
3.00	643.6	19.6	**32.8**
3.50	873.2	19.6	**44.6**
4.00	1074.2	19.6	**54.8**
4.50	1193.6	19.6	**60.9**
5.00	1317.2	19.6	**67.2**
5.50	1421.3	19.6	**72.5**
6.00	1498.0	19.6	**76.4**
6.50	1564.4	19.6	**79.8**
7.00	1627.3	19.6	**83.0**
7.50			
8.00			



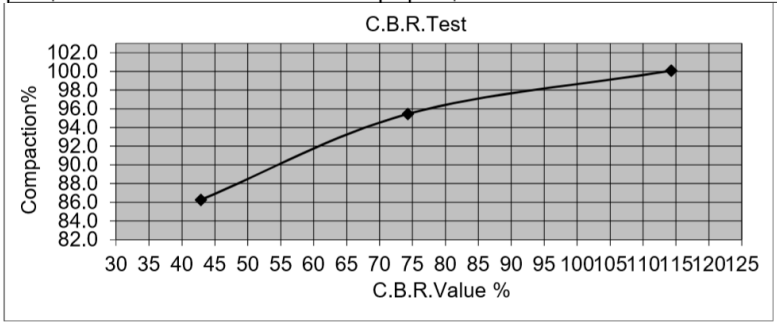
Corrected CBR at 2.5mm Penetration:
46.0 /70*100= 65.7 %
Corrected CBR at 5 mm Penetration:
78 /105*100 = 74.3 %
:. CBR = **74.3** %
Compaction = **95.4** %

Penetration Test (10 blows)

Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	4.9	19.6	**0.3**
0.50	14.5	19.6	**0.7**
0.75	28.2	19.6	**1.4**
1.00	41.7	19.6	**2.1**
1.50	98.5	19.6	**5.0**
2.00	184.7	19.6	**9.4**
2.50	302.8	19.6	**15.4**
3.00	402.5	19.6	**20.5**
3.50	503.8	19.6	**25.7**
4.00	584.2	19.6	**29.8**
4.50	658.5	19.6	**33.6**
5.00	734.8	19.6	**37.5**
5.50	812.4	19.6	**41.4**
6.00	874.5	19.6	**44.6**
6.50	918.9	19.6	**46.9**
7.00	963.4	19.6	**49.2**



Corrected CBR at 2.5mm Penetration:
25.0 /70*100= 35.7 %
Corrected CBR at 5 mm Penetration:
45 /105*100 = 42.9 %
:. CBR = **42.9** %
Compaction = **86.3** %



Test Result

:. C.B.R at 98% compaction= 94 %

4. LAA and AIV

Los Angeles Abrasion (LAA) Test of Base Course

Location : Sunkoshi -2 ,Kamere, Sindhuli (Om Buddha crusher)
Grading : A No. of spheres used : 12

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of sample W1 (g)	5000	5000	
2	Wt. of sample retained on 1.70 mm sieve after abrasion test W2 (g)	3305	3314	
3	Weight of loss (W1-W2) W3(g)	1695	1686	
4	LAA value (W3/W1*100) %	33.9	33.72	
5	Average LAA value (%)	33.81		

Aggregate Impact Value (AIV) Test of Base Course

Location : Sunkoshi -2 ,Kamere, Sindhuli (Om Buddha crusher)

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of measure + Compacted sample W1 (g)	1297.5	1286.5	
2	Wt. of cylindrical measures W2(g)	915.4	915.4	
3	Wt. of compacted sample W3(=W1-W2) g	382.1	371.1	
4	Wt. of sample passing on 2.36 mm sieve after test W4 (g)	68.8	71.3	
4	AIV= (W4/W3*100) %	18.01	19.21	
5	Average AIV (%)	18.61		

5. FI/EI and CR value

Combined Flakiness & Elongation Index of Base course

Location : Sunkoshi -2 ,Kamere, Sindhuli (Om Buddha crusher)

Flakiness plate Slot size Identification (mm)	Wt. retained on flakiness plate (g)	Wt. passing slot on flakiness plate (g)	Total weight tested for Flakiness (g)	Total Wt. tested for Elongation (Retained on flakiness plate) (g)	Wt. retained on Length gauge (g)
C	D	E	F=D+E	D	G
40 to 25	2300	312	2612	2300	54
25 to 19	780	254	1034	780	152
19 to 16	440	96	536	440	107
16 to 12.5	308	92	400	308	142
12.5 to 9.5	192	48	240	192	24
9.5 to 6.3	98	26	124	98	18
Total	4118	828	4946	4118	497

Flakiness Index, FI (%) =	*E/F *100 % =*	*16.74*
Elongation Index, EI (%) =	*G/D *100% =*	*12.07*
Combined FI + EI (%) =		**28.81**

Crushing Ratio (CR) Test of Base Course

Location : Sunkoshi -2 ,Kamere, Sindhuli (Om Buddha crusher)

S.N.	Description	Test Number		Remarks
		1	2	
1	Total wt. of Aggregate sample, W1 (g)	2345	2612	
2	Total wt. of crushed aggregates, W2 (g)	2102	2197	
4	Crushing ratio (CR) = W2/W1 *100 %	89.64	84.11	
5	Average Crushing ratio (CR)	86.87		

6. Specific Gravity and Water Absorption

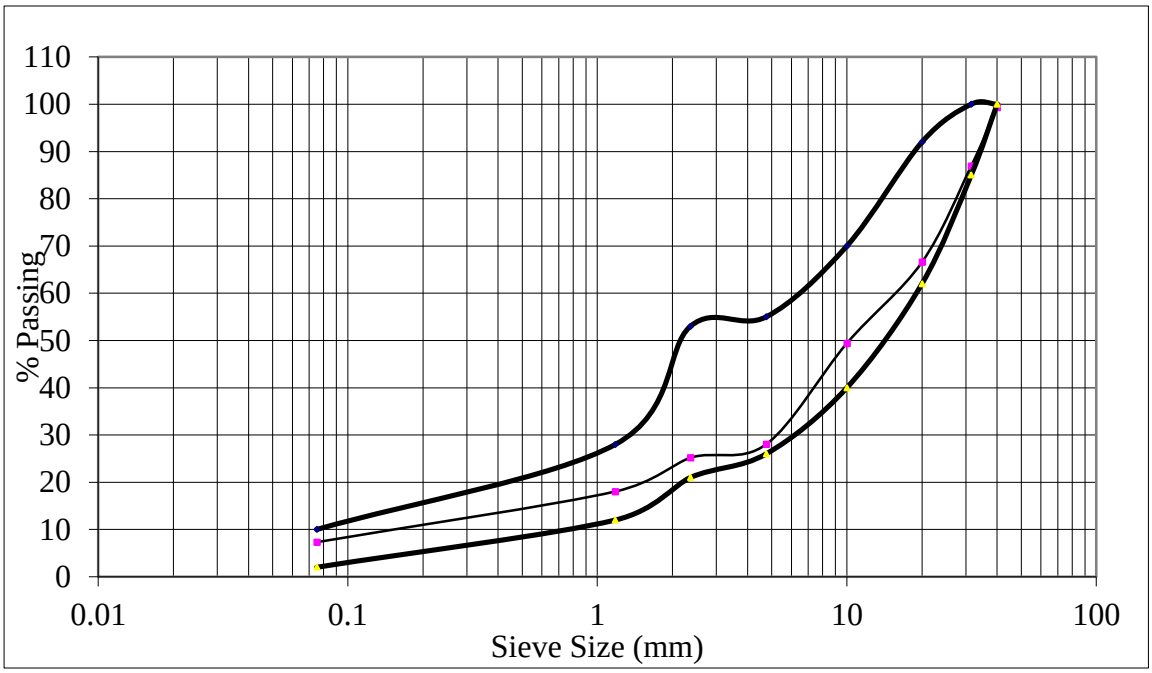
Location Om Buddha
Material: Base

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+Saturated, Surface Dry Sample	B1	2415.9
2	Wt. Pan	B2	438.9
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	1977
4	Wt. Basket + Sample in Water	C1	1785.3
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1237.6
7	Wt. of Oven Dry Sample	A	1966.8
	Bulk G (Oven Dry) = A/(B-C)		2.659995
	Bulk G (SSD) = B/(B-C)		2.67379
	Apparent G = A/(A-C)		2.697202
	Absorption=[(B-A)/A]*100%		0.52%

APPENDIX 8 LAB TESTS RESULTS OF BASE OF BHYAKUR KHOLA QUARRY

1. Sieve Analysis of Base (Bhyakur Khola)

Sieve Size (mm)	Specification		Weight Retained (g)	Weight Passing (g)	% Passing
	Lower Limit	Upper Limit			
40.00	100.00	100.00	126.0	18789.0	**99.3**
31.50	85.00	100.00	2344.0	16445.0	**86.9**
20.00	62.00	92.00	3854.0	12591.0	**66.6**
10.00	40.00	70.00	3244.0	9347.0	**49.4**
4.75	26.00	55.00	4045.0	5302.0	**28.0**
Pan			5302.0		
Total			**18915.0**		
2.36	21.00	53.00	71.6	633.6	**25.2**
1.18	12.00	28.00	179.8	453.8	**18.0**
0.075	2.00	10.00	269.8	184.0	**7.3**
Pan			184	0.0	**0.0**
Rep. Total			**705.2**		



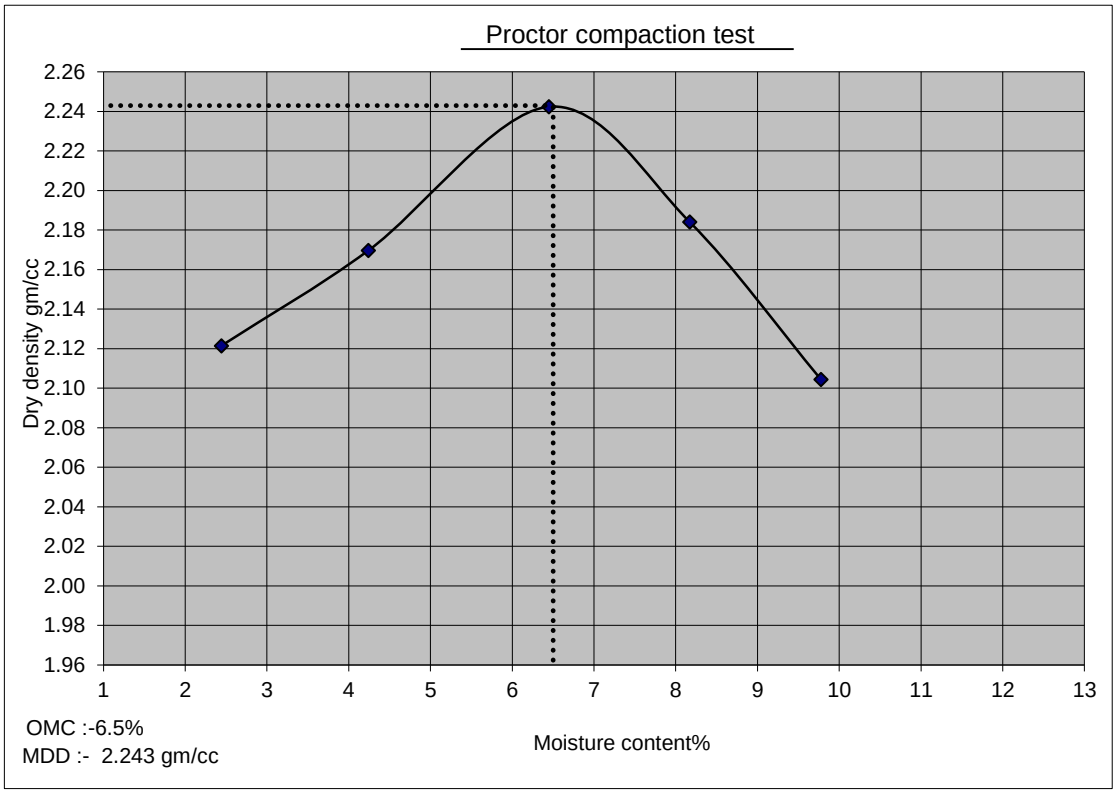
2. Modified Proctor Test of Base (Bhyakur Khola)

Density

Test No.	**1**	**2**	**3**	**4**	**5**
Cylinder+ Soil (g)	10504	10703	10985	10930	10812
Cylinder (g)	5612	5612	5612	5612	5612
Wet Soil (g)	4892	5091	5373	5318	5200
Wet density(g/cc)	**2.173**	**2.262**	**2.387**	**2.363**	**2.310**

Moisture content

Container No.	mk	4	A	Q	C
Wt. of Wet soil+ can(g)	943.6	987.4	873.6	897.5	964.7
Wt. of Dry soil+ can(g)	931.5	964.7	847.5	862.0	916.3
Wt. Can (g)	436.0	429.4	442.8	427.5	421.3
Wt. of Dry soil (g)	**495.5**	**535.3**	**404.7**	**434.5**	**495**
Et. Of Moisture (g)	**12.1**	**22.7**	**26.1**	**35.5**	**48.4**
Moisture content (%)	**2.44**	**4.24**	**6.45**	**8.17**	**9.78**
Dry density(g/cc)	**2.121**	**2.170**	**2.242**	**2.184**	**2.104**



3. CBR Test of Base (Bhyakur Khola)

Test condition	Before Soaking			After Soaking		
Mould No.	C	M	A	C	M	A
No. of Blows per layer	60	30	10	60	30	10
Wt. of wet Sample + Mould (g)	12376.00	12409.00	11970.00	12405.00	12451.00	12042.00
Wt. of mould (g)	7026.00	7466.00	7396.00	7026.00	7466.00	7396.00
Wt. of wet sample (g)	5350.00	4943.00	4574.00	5379.00	4985.00	4646.00
Volume of mould (cc)	2216.00	2185.40	2188.37	2216.00	2185.40	2188.37
Wet density (g/cc)	2.414	2.262	2.090	2.427	2.281	2.123
Av. Moisture content (%)	6.76	6.57	6.53	7.47	7.62	8.38
Dry unit weight (g/cc)	2.261	2.122	1.962	2.259	2.119	1.959
MDD (g/cc)	2.243	2.243	2.243			
Compaction (%)	100.8	94.6	87.5			
Swelling				-	-	-
Water absorption (%)				0.54	0.85	1.57

Moisture Content Determination												
Test condition	Before Soaking						After Soaking					
Mould No.	C		M		A		C		M		A	
Can no.	1	2	3	4	5	6	1	2	3	4	5	6
Wt. of can + Wet soil (g)	980.5	860.4	874.3	865.2	885.1	930.7	949.5	978.6	803.2	943.7	840.3	912.5
Wt. of can + dry soil (g)	945.4	831.4	848.1	838.8	858	898.1	913.1	941.2	773.9	908.3	806.4	873.1
Wt. of water (g)	35.1	29.0	26.2	26.4	27.1	32.6	36.4	37.4	29.3	35.4	33.9	39.4
Wt. of empty can (g)	427.5	401.8	448.2	438.4	439.5	402.7	427.3	439.6	402.5	427.3	402.6	401.8
Wt. of dry soil (g)	517.9	429.6	399.9	400.4	418.5	495.4	485.8	501.6	371.4	481.0	403.8	471.3
Moisture content %	6.78	6.75	6.55	6.59	6.48	6.58	7.49	7.46	7.89	7.36	8.40	8.36
Av. Moisture content %	6.76		6.57		6.53		7.47		7.62		8.38	

CBR Test Data for Base Course

Material Type : Base
Location : Kalo dhunga (Bhyakur khola), Roshi - 11, Kavre

Penetration Test (60 blows)

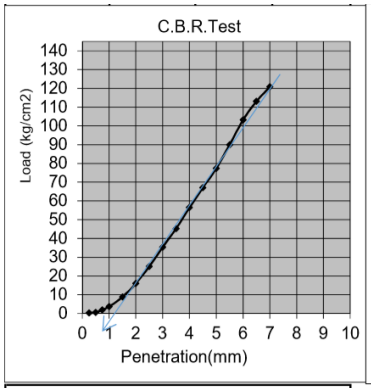
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	5.1	19.6	**0.3**
0.50	10.2	19.6	**0.5**
0.75	39.0	19.6	**2.0**
1.00	71.3	19.6	**3.6**
1.50	173.0	19.6	**8.8**
2.00	314.9	19.6	**16.1**
2.50	490.9	19.6	**25.0**
3.00	693.5	19.6	**35.4**
3.50	886.0	19.6	**45.2**
4.00	1106.2	19.6	**56.4**
4.50	1315.0	19.6	**67.1**
5.00	1516.2	19.6	**77.4**
5.50	1764.0	19.6	**90.0**
6.00	2022.0	19.6	**103.2**
6.50	2216.8	19.6	**113.1**
7.00	2367.0	19.6	**120.8**

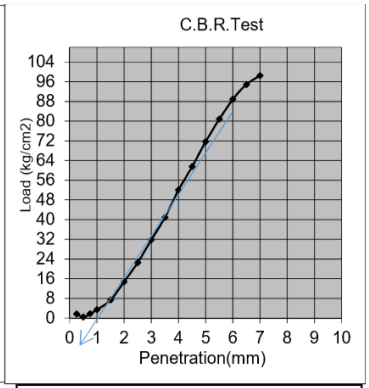
Penetration Test (30 blows)

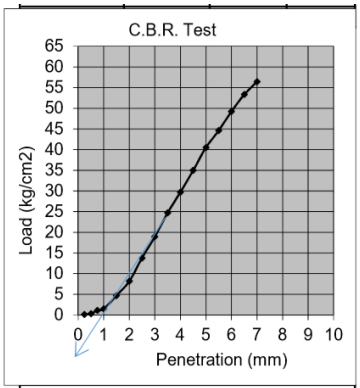
Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	32.0	19.6	**1.6**
0.50	8.2	19.6	**0.4**
0.75	34.2	19.6	**1.7**
1.00	66.3	19.6	**3.4**
1.50	144.2	19.6	**7.4**
2.00	290.3	19.6	**14.8**
2.50	442.2	19.6	**22.6**
3.00	623.2	19.6	**31.8**
3.50	802.3	19.6	**40.9**
4.00	1020.3	19.6	**52.1**
4.50	1205.3	19.6	**61.5**
5.00	1405.3	19.6	**71.7**
5.50	1583.5	19.6	**80.8**
6.00	1742.3	19.6	**88.9**
6.50	1860.4	19.6	**94.9**
7.00	1930.6	19.6	**98.5**
7.50			
8.00			
8.50			

Penetration Test (10 blows)

Penetration (mm)	Load, Kg	Area of plunger cm2	Load kg/cm^2
0.25	2.2	19.6	**0.1**
0.50	6.3	19.6	**0.3**
0.75	22.2	19.6	**1.1**
1.00	28.6	19.6	**1.5**
1.50	92.4	19.6	**4.7**
2.00	160.2	19.6	**8.2**
2.50	270.4	19.6	**13.8**
3.00	371.2	19.6	**18.9**
3.50	484.2	19.6	**24.7**
4.00	582.3	19.6	**29.7**
4.50	685.3	19.6	**35.0**
5.00	794.2	19.6	**40.5**
5.50	874.5	19.6	**44.6**
6.00	965.3	19.6	**49.3**
6.50	1045.6	19.6	**53.3**
7.00	1105.7	19.6	**56.4**



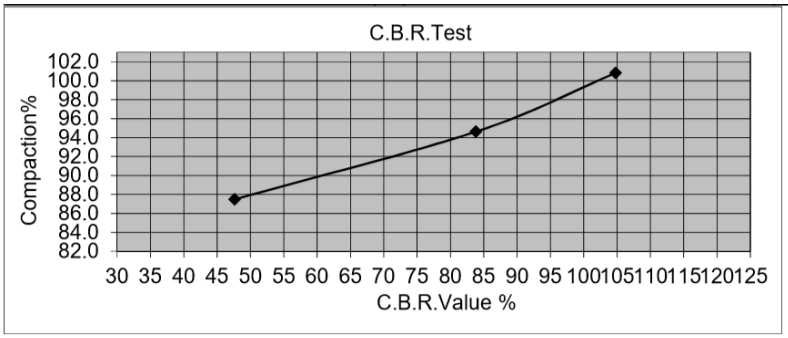




Corrected CBR at 2.5mm Penetration:
50 /70*100= **71.4** %
Corrected CBR at 5 mm Penetration:
110 /105*100 = **104.8** %
:. CBR = **104.8** %
Compaction = **100.8** %

Corrected CBR at 2.5mm Penetration:
32.0 /70*100= **45.7** %
Corrected CBR at 5 mm Penetration:
88 /105*100 = **83.8** %
:. CBR = **83.8** %
Compaction = **94.6** %

Corrected CBR at 2.5mm Penetration:
25.0 /70*100= **35.7** %
Corrected CBR at 5 mm Penetration:
50 /105*100 = **47.6** %
:. CBR = **47.6** %
Compaction = **87.5** %



Test Result

:. C.B.R at 98% compaction= 95 %

4. LAA and AIV

Los Angeles Abrasion (LAA) Test of Base Course

Location : Kalo dhunga (Bhyakur khola), Roshi - 11, Kavre
Grading : A No. of spheres used : 12

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of sample W1 (g)	5000	5000	
2	Wt. of sample retained on 1.70 mm seive after abrasion test W2 (g)	3150	3135	
3	Weight of loss (W1-W2) W3(g)	1850	1865	
4	LAA value (W3/W1*100) %	37.0	37.3	
5	Average LAA value (%)	37.15		

Aggregate Impact Value (AIV) Test of Base Course

Location : Kalo dhunga (Bhyakur khola), Roshi - 11, Kavre

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of measure + Compacted sample W1 (g)	1273.5	1264.6	
2	Wt. of cylindrical measures W2(g)	915.4	915.4	
3	Wt. of compacted sample W3(=W1-W2) g	358.1	349.2	
4	Wt. of sample passing on 2.36 mm sieve after test W4 (g)	98.4	95.7	
4	AIV= (W4/W3*100) %	27.48	27.41	
5	Average AIV (%)	27.44		

5. FI/EI and CR value

Combined Flakiness & Elongation Index of Base course

Location : Bhyakur Khola crusher

Flakiness plate Slot size Identification (mm)	Wt. retained on flakiness plate (g)	Wt. passing slot on flakiness plate (g)	Total weight tested for Flakiness (g)	Total Wt. tested for Elongation (Retained on flakiness plate) (g)	Wt. retained on Length gauge (g)
C	D	E	F=D+E	D	G
40 to 25	1486	252	1738	1486	134
25 to 19	1682	444	2126	1682	206
19 to 16	370	60	430	370	102
16 to 12.5	738	256	994	738	128
12.5 to 9.5	254	122	376	254	46
9.5 to 6.3	144	40	184	144	22
Total	4674	1174	5848	4674	638

*Flakiness Index, FI (%) = E/F *100 % = 20.08*
*Elongation Index, EI (%) = G/D *100% = 13.65*
Combined FI + EI (%) = 33.73

Crushing Ratio (CR) Test of Base Course

Location : Kalo dhunga (Bhyakur khola), Roshi - 11, Kavre

S.N.	Description	Test Number		Remarks
		1	2	
1	Total wt. of Aggregate sample, W1 (g)	2148	2427	
2	Total wt. of crushed aggregates, W2 (g)	1856	2049	
4	Crushing ratio (CR) = W2/W1 *100 %	86.41	84.43	
5	Average Crushing ratio (CR)	85.42		

6. Specific Gravity and Water Absorption

Location Bhyakure Khola (Kalo Dhunga)
Material: Base

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+Saturated, Surface Dry Sample	B1	2264.4
2	Wt. Pan	B2	423.8
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	1840.6
4	Wt. Basket + Sample in Water	C1	1697.4
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1149.7
7	Wt. of Oven Dry Sample	A	1826.9
	Bulk G (Oven Dry) = A/(B-C)		2.644232
	Bulk G (SSD) = B/(B-C)		2.664061
	Apparent G = A/(A-C)		2.697726
	Absorption=[(B-A)/A]*100%		0.75%

APPENDIX 9 LAB TESTS RESULTS OF SURFACE COURSE OF CHALLAL GANESH QUARRY

1. Sieve Analysis of surface course (Chalaal Ganeshthan)

20mm				
IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
26.50	686	11408	5.67%	94.33%
20.00	3510	7898	34.69%	65.31%
16.00	2028	5870	51.46%	48.54%
13.20	2772	3098	74.38%	25.62%
10.00	2226	872	92.79%	7.21%
4.75	798	74	99.39%	0.61%
2.36	42	32	99.74%	0.26%
0.60	20	12	99.90%	0.10%
Pan	12	0	100.00%	0.00%
Total	12094			

10mm				
IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
13.20	42	9046	0.46%	99.54%
10.00	2304	6742	25.81%	74.19%
4.75	6616	126	98.61%	1.39%
2.36	34	92	98.99%	1.01%
0.60	50	42	99.54%	0.46%
Pan	42	0	100.00%	0.00%
Total	9088			

Dust (4.75 mm)				
IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
4.75	103.6	529.3	16.37%	83.63%
2.36	84	445.3	29.64%	70.36%
1.18	122.8	322.5	49.04%	50.96%
0.60	65.3	257.2	59.36%	40.64%
0.30	57.4	199.8	68.43%	31.57%
0.15	20.8	179	71.72%	28.28%
0.075	68.9	110.1	82.60%	17.40%
Total	632.9			

2. Job Mix Design (Chalaal Ganeshthan)

Bituminous Macadam					
Sieve Size (mm)	20mm (28%)	10 mm (50%)	4.75mm (22%)	Total	SSRBW, 2073 (% Passing range)
26.50	26.41%	50.00%	22.00%	99.41%	100
19.00	18.29%	50.00%	22.00%	90.29%	90-100
13.20	7.17%	49.77%	22.00%	78.94%	56-88
10.00	2.02%	37.09%	22.00%	61.11%	
4.75	0.17%	0.69%	18.40%	19.26%	16-36
2.36	0.07%	0.51%	15.48%	16.06%	4-19
1.18	0.03%	0.23%	11.21%	11.47%	
0.60	0.03%	0.23%	8.94%	9.20%	
0.30	0.00%	0.00%	6.95%	6.95%	2-10
0.15	0.00%	0.00%	6.22%	6.22%	
0.075	0.00%	0.00%	3.83%	3.83%	0-8

Dense Bituminous Macadam					
Sieve Size (mm)	20mm (28%)	10 mm (27%)	4.75mm (45%)	Total	SSRBW, 2073 (% Passing range)
37.50	28.00%	27.00%	45.00%	100.00%	100
26.50	26.41%	27.00%	45.00%	98.41%	90-100
19.00	18.28%	27.00%	45.00%	90.28%	71-95
13.20	7.17%	26.88%	45.00%	79.05%	56-80
9.50	2.02%	20.03%	45.00%	67.05%	
4.75	0.17%	0.37%	37.63%	38.18%	38-54
2.36	0.07%	0.27%	31.66%	32.01%	28-42
1.18	0.03%	0.12%	22.93%	23.08%	
0.60	0.02%	0.00%	18.29%	18.31%	
0.30	0.00%	0.00%	14.21%	14.21%	7-21
0.15	0.00%	0.00%	12.73%	12.73%	
0.075	0.00%	0.00%	7.83%	7.83%	2-8

Asphalt Concrete					
Sieve Size (mm)	20mm (30%)	10 mm (27%)	4.75mm (43%)	Total	SSRBW, 2073 (% Passing range)
26.50	28.30%	27.00%	43.00%	98.30%	100%
19.00	19.60%	27.00%	43.00%	89.60%	90-100
13.20	7.68%	26.88%	43.00%	77.56%	59-79
10.00	2.16%	20.03%	43.00%	65.19%	52-72
4.75	0.18%	0.37%	35.96%	36.52%	35-55
2.36	0.07%	0.27%	30.25%	30.60%	28-44
1.18	3.00%	0.12%	21.91%	22.07%	20-34
0.60	0.03%	0.47%	17.47%	17.95%	15-27
0.30	0.00%	0.00%	13.57%	13.57%	10-20
0.15	0.00%	0.00%	12.16%	12.16%	5-13
0.075	0.00%	0.00%	7.48%	7.48%	2-8

3. FI/EI of Wearing course

Combined Flakiness & Elongation Index of Wearing course

Location : Bethanchowk -4, Kavre (Chalal Ganeshthan)

Flakiness plate Slot size Indefication (mm)	Wt. retained on flakiness plate (g)	Wt.passing slot on flakiness plate (g)	Total weight tested for Flikeness (g)	Total Wt. tested for Elongation (Retained on falkiness plate) (g)	Wt. retined on Length gauge (g)
C	D	E	F=D+E	D	G
25 to 19	1320	236	1556	1320	106
19 to 16	694	128	822	694	98
16 to 12.5	543	98	641	543	136
12.5 to 9.5	498	234	732	498	93
9.5 to 6.3	184	65	249	184	54
Total	3239	761	4000	3239	487

Flakiness Index, FI (%) =	*E/F *100 % =*	*19.03*
Elongation Index, EI (%) =	*G/D *100% =*	*15.04*
Combined FI + EI (%) =		**34.06**

4. **Specific Gravity of wearing course (Challal Ganeshsthan)**

20 mm down

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+ Saturated, Surface Dry Sample	B1	2266.3
2	Wt. Pan	B2	424.8
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	1841.5
4	Wt. Basket + Sample in Water	C1	1707.4
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1159.7
7	Wt. of Oven Dry Sample	A	1832.6
	Bulk G (Oven Dry) = A/(B-C)		2.688
	Bulk G (SSD) = B/(B-C)		2.701
	Apparent G = A/(A-C)		2.723
	Absorption=[(B-A)/A]*100%		0.49%

10 mm down

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+ Saturated , Surface Dry Sample	B1	2246.7
2	Wt. Pan	B2	439.8
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	1806.9
4	Wt. Basket + Sample in Water	C1	1685.9
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1138.2
7	Wt. of Oven Dry Sample	A	1798
	Bulk G (Oven Dry) = A/(B-C)		2.689
	Bulk G (SSD) = B/(B-C)		2.702
	Apparent G = A/(A-C)		2.725
	Absorption=[(B-A)/A]*100%		0.49%

Dust 4.75mm down

S.N	Determination Number	Notation	Weight	
1	Wt. PYC + Water (full)	A	742.5	G
2	Wt. PYC Empty and Dry	B	219.9	G
3	Temp of Water	T1	25°C	
4	Wt. PYC + Oven Dry Sample	C	1753	G
5	Wt. of Oven Dry Sample= C-B	D	524	G
6	Wt. PYC+ Sample + Water (Full)	E	1072.8	G
7	Temp of Water	T2	25°C	
8	Rel. Density of Water at temp T2	GW	0.997077	
9	Specific Gravity= GW*(D/D+A-E)		2.697	

5. LAA and AIV of Wearing course

Los Angeles Abrasion (LAA) Test

Location : Bethanchowk -4, Kavre (Chalal Ganeshthan)
Grading : B No. of spheres used :11

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of sample W1 (g)	5000	5000	
2	Wt. of sample retained on 1.70 mm sieve after abrasion test W2 (g)	3698	3697	
3	Weight of loss (W1-W2) W3(g)	1302	1303	
4	LAA value (W3/W1*100) %	26.04	26.06	
5	Average LAA value (%)	26.05		

Aggregate Impact Value (AIV) Test Wearing Course

Location : Bethanchowk -4, Kavre (Chalal Ganeshthan)

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of measure + Compacted sample W1 (g)	1252.2	1244.6	
2	Wt. of cylindrical measures W2(g)	915.4	915.4	
3	Wt. of compacted sample W3(=W1-W2) g	336.8	329.2	
4	Wt. of sample passing on 2.36 mm sieve after test W4 (g)	62.8	61.4	
4	AIV= (W4/W3*100) %	18.65	18.65	
5	Average AIV (%)	18.65		

APPENDIX 10 LAB TESTS RESULTS OF SURFACE COURSE OF AAPGHARI QUARRY

1. Sieve Analysis of surface course (Ghyampe Khola , Aapghari)

20mm				
IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
26.50	0	6731	0.00%	100.00%
20.00	2006	3617	29.08%	70.20%
10.00	4709	872	87.05%	12.95%
4.75	12	74	98.90%	1.10%
Pan	5	0	100.00%	0.00%
Total	6732			

10mm				
IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
13.20	0	4331	0.00%	100.00%
10.00	436	3895	10.07%	89.93%
4.75	3706	189	95.64%	4.36%
2.36	106	83	98.08%	1.92%
0.60	32	51	98.82%	1.18%
0.075	42	9	99.79%	0.21%
Pan	9	0	100.00%	0.00%
Total	4331			

Dust (4.75 mm)				
IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
4.75	3.2	563.6	0.56%	99.44%
2.36	6.4	557.2	1.69%	98.31%
1.18	70.3	486.9	14.10%	85.90%
0.60	72.1	414.8	26.82%	73.18%
0.30	128.4	286.4	49.47%	50.53%
0.15	88.4	198	65.07%	34.93%
0.075	43.8	154.2	72.79%	27.21%
Total	566.8			

2. Job Mix Design of Ghyampe Khola (Aapghari)

Bituminous Macadam					
Sieve Size (mm)	20mm (35%)	10 mm (50%)	4.75mm (15%)	Total	SSRBW, 2073 (% Passing range)
26.50	35.00%	50.00%	15.00%	100.00%	100
19.00	24.57%	50.00%	15.00%	89.57%	90-100
13.20	4.53%	50.00%	15.00%	69.53%	56-88
10.00	4.53%	44.97%	15.00%	64.50%	
4.75	0.38%	2.18%	14.92%	17.48%	16-36
2.36	0.00%	0.96%	14.75%	15.70%	4-19
1.18	0.00%	0.59%	12.89%	13.48%	
0.60	0.00%	0.59%	10.98%	11.57%	
0.30	0.00%	0.11%	7.58%	7.69%	2-10
0.15	0.00%	0.11%	5.24%	5.35%	
0.075	0.00%	0.11%	4.08%	4.19%	0-8

Dense Bituminous Macadam					
Sieve Size (mm)	20mm (34%)	10 mm (37%)	4.75mm (29%)	Total	SSRBW, 2073 (% Passing range)
37.50	34.00%	37.00%	29.00%	100.00%	100
26.50	34.00%	37.00%	29.00%	100.00%	90-100
19.00	23.87%	37.00%	29.00%	89.87%	71-95
13.20	4.40%	37.00%	29.00%	70.40%	56-80
9.50	4.40%	33.27%	29.00%	66.67%	
4.75	0.37%	1.61%	28.83%	30.81%	38-54
2.36	0.00%	0.71%	28.50%	29.21%	28-42
1.18	0.00%	0.43%	24.91%	25.34%	
0.60	0.00%	0.43%	21.22%	21.65%	
0.30	0.00%	0.07%	14.65%	14.72%	7-21
0.15	0.00%	0.07%	10.13%	10.20%	
0.075	0.00%	0.07%	7.78%	7.85%	2-8

Asphalt Concrete					
Sieve Size (mm)	20mm (30%)	10 mm (41%)	4.75mm (29%)	Total	SSRBW, 2073 (% Passing range)
26.50	30.00%	41.00%	29.00%	100.00%	100%
19.00	21.06%	41.00%	29.00%	91.06%	90-100
13.20	3.89%	41.00%	29.00%	73.89%	59-79
10.00	3.89%	36.87%	29.00%	69.76%	52-72
4.75	0.33%	1.79%	28.83%	30.95%	35-55
2.36	0.00%	0.79%	28.50%	29.29%	28-44
1.18	0.00%	0.48%	24.91%	25.39%	20-34
0.60	0.00%	0.48%	21.22%	21.31%	15-27
0.30	0.00%	0.09%	14.65%	14.74%	10-20
0.15	0.00%	0.09%	10.13%	10.22%	5-13
0.075	0.00%	0.09%	7.89%	7.98%	2-8

3. FI/EI of Wearing Course

Combined Flakiness & Elongation Index of Wearing course

Location : Sunkoshi -1, Sindhuli ,Ghyampe Khola (Aapghari)

Flakiness plate Slot size Indication (mm)	Wt. retained on flakiness plate (g)	Wt. passing slot on flakiness plate (g)	Total weight tested for Flakiness (g)	Total Wt. tested for Elongation (Retained on flakiness plate) (g)	Wt. retined on Length gauge (g)
C	D	E	F=D+E	D	G
25 to 19	1305	312	1617	1305	212
20 to 16	719	132	851	719	87
16 to 12.5	530	86	616	530	98
12.5 to 9.5	160	41	201	160	36
9.5 to 6.3	75	18	93	75	18
Total	2789	589	3378	2789	451

*Flakiness Index, FI (%) = E/F *100 % = 17.44*
*Elongation Index, EI (%)= G/D *100% = 16.17*
Combined FI + EI (%) = 33.61

4. Specific Gravity of Wearing Course (Ghyampe Khola, Aapghari)

20 mm crushed down

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+ Saturated, Surface Dry Sample	B1	2315.6
2	Wt. Pan	B2	434.9
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	1880.7
4	Wt. Basket + Sample in Water	C1	1729
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1181.3
7	Wt. of Oven Dry Sample	A	1862.6
	Bulk G (Oven Dry) = A/(B-C)		2.663
	Bulk G (SSD) = B/(B-C)		2.689
	Apparent G = A/(A-C)		2.734
	Absorption=[(B-A)/A]*100%		0.97%

10 mm crushed aggregate

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+ Saturated, Surface Dry Sample	B1	2326.3
2	Wt. Pan	B2	425.7
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	1900.6
4	Wt. Basket + Sample in Water	C1	1724.2
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1176.5
7	Wt. of Oven Dry Sample	A	1886.7
	Bulk G (Oven Dry) = A/(B-C)		2.605
	Bulk G (SSD) = B/(B-C)		2.625
	Apparent G = A/(A-C)		2.656
	Absorption=[(B-A)/A]*100%		0.74%

Dust 4.75mm down

S.N	Detenination Number	Notation	Weight	
1	Wt. PYC + Water (full)	A	749.1	g
2	Wt. PYC Empty and Dry	B	234.9	g
3	Temp of Water	T1	25°C	
4	Wt. PYC + Oven Dry Sample	C	748.7	g
5	Wt. of Oven Dry Sample= C-B	D	513.8	g
6	Wt. PYC+ Sample + Water (Full)	E	1065.6	g
7	Temp of Water	T2	25°C	
8	Rel Density of Water at temp T2	GW	0.997077	
9	Specific Gravity= GW*(D/D+A-E)		2.596	

5. LAA and AIV of Wearing Course

Los Angeles Abrasion (LAA) Test

Location : Sunkoshi -1, Sindhuli ,Ghyampe Khola (Aapghari)
Grading : B No. of spheres used : 11

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of sample W1 (g)	5000	5000	
2	Wt. of sample retained on 1.70 mm sieve after abrasion test W2 (g)	3576	3575	
3	Weight of loss (W1-W2) W3(g)	1424	1425	
4	LAA value (W3/W1*100) %	28.48	28.5	
5	Average LAA value (%)	28.49		

Aggregate Impact Value (AIV) Test

Location : Sunkoshi -1, Sindhuli ,Ghyampe Khola (Aapghari)

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of measure + Compacted sample W1 (g)	1234.5	1263.3	
2	Wt. of cylindrical measures W2(g)	915.4	915.4	
3	Wt. of compacted sample W3(=W1-W2) g	319.1	347.9	
4	Wt. of sample passing on 2.36 mm sieve after test W4 (g)	63.2	68.5	
4	AIV= (W4/W3*100) %	19.81	19.69	
5	Average AIV (%)	19.75		

APPENDIX 11 LAB TESTS RESULTS OF SURFACE COURSE OF OM BUDDHA QUARRY

1. Sieve Analysis of Wearing Course (Om Buddha)

20mm crushed

IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
26.50	0	9459	0.00%	100.00%
20.00	1280	8179	13.53%	86.47%
14.00	7382	797	91.57%	8.43%
10.00	736	61	99.36%	0.64%
4.75	54	7	99.93%	0.07%
Pan	7	0	100.00%	0.00%
Total	9459			

10mm crushed

IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
13.20	0	6536	0.00%	100.00%
10.00	2736	3800	41.86%	58.14%
4.75	3534	266	95.93%	4.07%
2.36	88	178	97.28%	2.72%
0.60	46	132	97.98%	2.02%
0.075	116	16	99.76%	0.24%
Pan	16	0	100.00%	
Total	6536			

Dust (4.75 mm)

IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
4.75	21.6	516.8	4.01%	95.99%
2.36	49.8	467.0	13.26%	86.74%
1.18	123.5	343.5	36.20%	63.80%
0.60	59.2	284.3	47.20%	52.80%
0.30	80.5	203.8	62.15%	37.85%
0.15	72.5	131.3	75.61%	24.39%
0.075	32.9	98.4	81.72%	18.28%
Total	538.4			

2. Job Mix Design

Bituminous Macadam					
Sieve Size (mm)	20mm (30%)	10 mm (50%)	4.75mm (20%)	Total	SSRBW, 2073 (% Passing range)
26.5	30.00%	50.00%	20.00%	100.00%	100
19	25.94%	50.00%	20.00%	95.94%	90-100
13.2	2.53%	50.00%	20.00%	72.53%	56-88
10	0.19%	29.07%	20.00%	49.26%	
4.75	0.02%	2.03%	19.20%	21.25%	16-36
2.36	0.00%	1.36%	17.35%	18.71%	4-19
1.18	0.00%	1.01%	12.76%	13.77%	
0.6	0.00%	1.01%	10.56%	11.57%	
0.3	0.00%	0.12%	7.57%	7.69%	2-10
0.15	0.00%	0.12%	4.88%	5.00%	
0.075	0.00%	0.12%	3.66%	3.78%	0-8

Dense Bituminous Macadam					
Sieve Size (mm)	20mm (35%)	10 mm (26%)	4.75mm (39%)	Total	SSRBW, 2073 (% Passing range)
37.5	35.00%	26.00%	39.00%	100.00%	100
26.5	35.00%	26.00%	39.00%	100.00%	90-100
19	30.26%	26.00%	39.00%	95.26%	71-95
13.2	2.95%	26.00%	39.00%	67.95%	56-80
9.5	0.23%	15.11%	39.00%	54.34%	
4.75	0.03%	1.05%	37.44%	38.51%	38-54
2.36	0.00%	0.71%	33.83%	34.54%	28-42
1.18	0.00%	0.52%	24.88%	25.40%	
0.6	0.00%	0.52%	20.59%	21.11%	
0.3	0.00%	0.06%	14.76%	14.82%	7-21
0.15	0.00%	0.06%	9.51%	9.57%	
0.075	0.00%	0.06%	7.13%	7.19%	2-8

Asphalt Concrete					
Sieve Size (mm)	20mm (25%)	10 mm (40%)	4.75mm (35%)	Total	SSRBW, 2073 (% Passing range)
26.50	25.00%	40.00%	35.00%	100.00%	100%
19.00	21.62%	40.00%	35.00%	96.62%	90-100
13.20	2.11%	40.00%	35.00%	77.11%	59-79
10.00	0.16%	23.26%	35.00%	58.42%	52-72
4.75	0.02%	1.63%	33.60%	35.24%	35-55
2.36	0.00%	1.09%	30.36%	31.45%	28-44
1.18	0.00%	0.81%	22.33%	23.14%	20-34
0.60	0.00%	0.81%	18.48%	19.29%	15-27
0.30	0.00%	0.01%	13.25%	13.26%	10-20
0.15	0.00%	0.01%	8.54%	8.55%	5-13
0.075	0.00%	0.01%	6.40%	6.41%	2-8

3. FI/EI of Wearing Course

Combined Flakiness & Elongation Index of Wearing course

Location : Sunkoshi -2 ,Kamere, Sindhuli (Om Buddha crusher)

Flakiness plate Slot size Indefication (mm)	Wt. retained on flakiness plate (g)	Wt.passing slot on flakiness plate (g)	Total weight tested for Flikeness (g)	Total Wt. tested for Elongation (Retained on falkiness plate) (g)	Wt. retined on Length gauge (g)
C	D	E	F=D+E	D	G
25 to 19	976	193	1169	976	139
19 to 16	890	238	1128	890	98
16 to 12.5	743	180	923	743	91
12.5 to 9.5	367	154	521	367	94
9.5 to 6.3	172	36	208	172	33
Total	3148	801	3949	3148	455

Flakiness Index, FI (%) =	*E/F *100 % =*	*20.28*
Elongation Index, EI (%) =	*G/D *100% =*	*14.45*
Combined FI + EI (%) =		**34.74**

4. Specific Gravity of Wearing Course

20 mm natural

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+ Saturated, Surface Dry Sample	B1	2557.6
2	Wt. Pan	B2	439.9
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	2117.7
4	Wt. Basket + Sample in Water	C1	1871.7
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1324
7	Wt. of Oven Dry Sample	A	2105.5
	Bulk G (Oven Dry) = A/(B-C)		2.653
	Bulk G (SSD) = B/(B-C)		2.668
	Apparent G = A/(A-C)		2.694
	Absorption=[(B-A)/A]*100%		0.58%

10 mm crushed

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+ Saturated, Surface Dry Sample	B1	2155.6
2	Wt. Pan	B2	435.8
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	1719.8
4	Wt. Basket + Sample in Water	C1	1603.9
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1056.2
7	Wt. of Oven Dry Sample	A	1702.9
	Bulk G (Oven Dry) = A/(B-C)		2.566
	Bulk G (SSD) = B/(B-C)		2.592
	Apparent G = A/(A-C)		2.633
	Absorption=[(B-A)/A]*100%		0.99%

Dust 4.75mm down

S.N	Detenination Number	Notation	Weight	
1	Wt. PYC + Water (full)	A	742.5	G
2	Wt. PYC Empty and Dry	B	219.8	G
3	Temp of Water	T1	25°C	
4	Wt. PYC + Oven Dry Sample	C	811	G
5	Wt. of Oven Dry Sample= C-B	D	524	G
6	Wt. PYC+ Sample + Water (Full)	E	1098.1	G
7	Temp of Water	T2	25°C	
8	Rel Density of Water at temp T2	GW	0.997077	
9	Specific Gravity= GW*(D/D+A-E)		3.102	

5. LAA and AIV of Wearing Course

Los Angeles Abrasion (LAA) Test

Location : Sunkoshi -2 ,Kamere, Sindhuli (Om Buddha crusher)
Grading : B No. of spheres used : 11

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of sample W1 (g)	5000	5000	
2	Wt. of sample retained on 1.70 mm sieve after abrasion test W2 (g)	3532	3533	
3	Weight of loss (W1-W2) W3(g)	1468	1467	
4	LAA value (W3/W1*100) %	29.36	29.34	
5	Average LAA value (%)	29.35		

Aggregate Impact Value (AIV) Test

Location : Sunkoshi -2 ,Kamere, Sindhuli (Om Buddha crusher)

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of measure + Compacted sample W1 (g)	1297.5	1286.5	
2	Wt. of cylindrical measures W2(g)	915.4	915.4	
3	Wt. of compacted sample W3(=W1-W2) g	382.1	371.1	
4	Wt. of sample passing on 2.36 mm sieve after test W4 (g)	68.8	71.3	
4	AIV= (W4/W3*100) %	18.01	19.21	
5	Average AIV (%)	18.61		

APPENDIX 12 LAB TESTS RESULTS OF SURFACE COURSE OF BHYAKUR KHOLA QUARRY

1. Sieve Analysis

20mm Crushed

IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
20.00	1790	7336	19.61%	80.39%
10.00	7042	294	96.78%	3.22%
4.75	270	24	99.74%	0.26%
Pan	24	0	100.00%	0.00%
Total	9126			

10mm Crushed

IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
13.20	0	6550	0.00%	100.00%
10.00	3756	2794	57.34%	42.66%
4.75	2566	228	96.52%	3.48%
Pan	228	0	100.00%	0.00%
Total	6550			

Dust (4.75 mm)

IS Sieve Designation (mm)	Wt. retained individual (g)	Cum. Wt. passing (%)	Cumulative Percentage of Wt. retained (%)	Cum .Percentage of Wt. Passing (%)
4.75	115.7	417.3	21.71%	78.29%
2.36	46.7	370.6	30.47%	69.53%
1.18	88.2	282.4	47.02%	52.98%
0.60	35.5	246.9	53.68%	46.32%
0.30	61.5	185.4	65.22%	34.78%
0.15	49.2	136.2	74.45%	25.55%
0.075	27.7	108.5	79.64%	20.36%
Total	533			

2. Job Mix Design of Bhyakur Khola

Bituminous Macadam					
Sieve Size (mm)	20mm (30%)	10 mm (50%)	4.75mm (20%)	Total	SSRBW, 2073 (% Passing range)
26.50	30.00%	50.00%	20.00%	100.00%	100
19.00	24.12%	50.00%	20.00%	94.12%	90-100
13.20	0.97%	50.00%	20.00%	70.97%	56-88
10.00	0.97%	21.33%	20.00%	42.30%	
4.75	0.08%	1.74%	15.66%	17.48%	16-36
2.36	0.00%	0.00%	13.91%	13.91%	4-19
1.18	0.00%	0.00%	10.60%	10.60%	
0.60	0.00%	0.00%	9.26%	9.26%	
0.30	0.00%	0.00%	6.96%	6.96%	2-10
0.15	0.00%	0.00%	5.11%	5.11%	
0.075	0.00%	0.00%	4.07%	4.07%	0-8

Dense Bituminous Macadam					
Sieve Size (mm)	20mm (25%)	10 mm (35%)	4.75mm (45%)	Total	SSRBW, 2073 (% Passing range)
37.50	25.00%	30.00%	45.00%	100.00%	100
26.50	25.00%	30.00%	45.00%	100.00%	90-100
19.00	20.09%	30.00%	45.00%	95.09%	71-95
13.20	0.80%	30.00%	45.00%	75.80%	56-80
9.50	0.80%	12.18%	45.00%	57.98%	
4.75	6.00%	1.04%	35.23%	42.27%	38-54
2.36	0.00%	0.00%	31.28%	31.28%	28-42
1.18	0.00%	0.00%	23.84%	23.84%	
0.60	0.00%	0.00%	20.84%	20.84%	
0.30	0.00%	0.00%	15.65%	15.65%	7-21
0.15	0.00%	0.00%	11.49%	11.49%	
0.075	0.00%	0.00%	9.16%	9.16%	2-8

Asphalt Concrete					
Sieve Size (mm)	20mm (25%)	10 mm (32%)	4.75mm (44%)	Total	SSRBW, 2073 (% Passing range)
26.5	25.00%	32.00%	43.00%	100.00%	100%
20	20.10%	32.00%	43.00%	95.10%	90-100
13.2	0.81%	32.00%	43.00%	75.81%	59-79
10	0.80%	13.65%	43.00%	57.45%	52-72
4.75	0.07%	1.11%	34.45%	35.63%	35-55
2.36	0.00%	0.00%	30.59%	30.59%	28-44
1.18	0.00%	0.00%	23.31%	23.31%	20-34
0.6	0.00%	0.00%	20.38%	20.38%	15-27
0.3	0.00%	0.00%	15.31%	15.31%	10-20
0.15	0.00%	0.00%	11.24%	11.24%	5-13
0.075	0.00%	0.00%	8.96%	8.96%	2-8

3. FI/EI of Wearing Course

Combined Flakiness & Elongation Index of Wearing course

Location : Bhyakur Khola

Flakiness plate Slot size Indefication (mm)	Wt. retained on flakiness plate (g)	Wt.passing slot on flakiness plate (g)	Total weight tested for Flikeness (g)	Total Wt. tested for Elongation (Retained on falkiness plate) (g)	Wt. retined on Length gauge (g)
C	D	E	F=D+E	D	G
25 to 19	912	248	1160	912	124
19 to 16	890	175	1065	890	97
16 to 12.5	376	84	460	376	54
12.5 to 9.5	215	58	273	215	68
9.5 to 6.3	124	32	156	124	13
Total	2517	597	3114	2517	356

*Flakiness Index, FI (%) = E/F *100 % = 19.17*
*Elongation Index, EI (%)= G/D *100% = 14.14*
Combined FI + EI (%) = 33.32

4. Specific Gravity

20 mm down

S.N	Detenination Number	Notation	Weight (g)
1	Wt. Pan+ Saturated, Surface Dry Sample	B1	2362.5
2	Wt. Pan	B2	418.3
3	Wt. Saturated, Surface Dry Sample(B1-B2)	B	1944.2
4	Wt. Basket + Sample in Water	C1	1762.5
5	Wt. Basket in Water	C2	547.7
6	Wt. Sample in water (C1-C2)	C	1214.8
7	Wt. of Oven Dry Sample	A	1929.8
	Bulk G (Oven Dry) = A/(B-C)		2.646
	Bulk G (SSD) = B/(B-C)		2.665
	Apparent G = A/(A-C)		2.699
	Absorption=[(B-A)/A]*100%		0.75%

Dust 4.75mm down

S.N	Detenination Number	Notation	Weight	
1	Wt. PYC + Water (full)	A	734.3	g
2	Wt. PYC Empty and Dry	B	220	g
3	Temp of Water	T1	25°C	
4	Wt. PYC + Oven Dry Sample	C	736.7	g
5	Wt. of Oven Dry Sample= C-B	D	516.7	g
6	Wt. PYC+ Sample + Water (Full)	E	1047.7	g
7	Temp of Water	T2	25°C	
8	Rel Density of Water at temp T2	GW	0.997077	
9	Specific Gravity= GW*(D/D+A-E)		2.534	

5. LAA and AIV

Location : Kalo dhunga (Bhyakur khola), Roshi - 11, Kavre
Grading : B No. of spheres used : 11

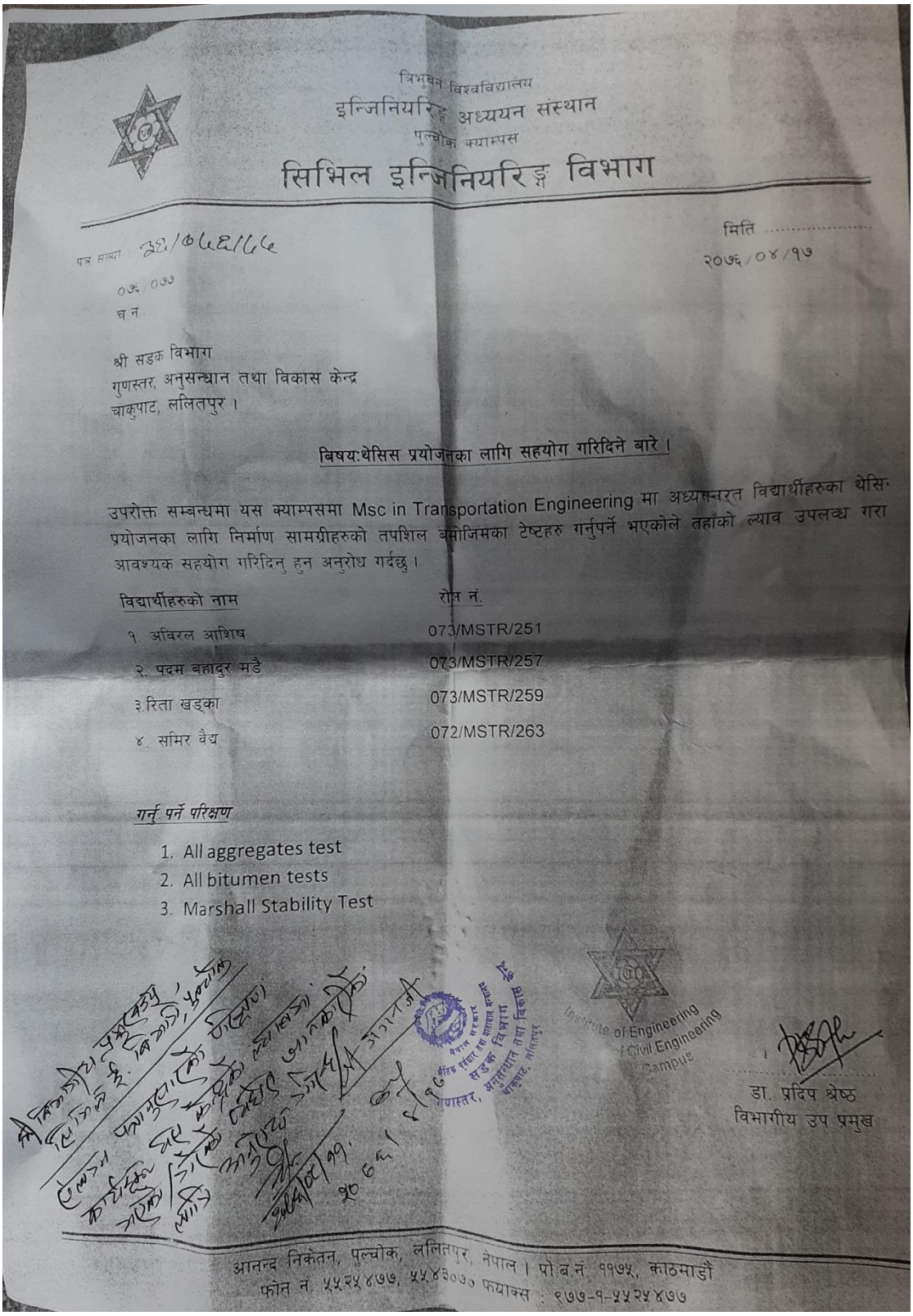
S.N.	Description	Test Number		Remarks
		1	2	
1		5000	5000	
2	Wt. of sample retained on 1.70 mm seive after abrasion test W2 (g)	3393	3376	
3	Weight of loss (W1-W2) W3(g)	1607	1624	
4	LAA value (W3/W1*100) %	32.1	32.48	
5	Average LAA value (%)	32.30		

Aggregate Impact Value (AIV)

Location : Location : Roshi - 11, Kavre (Bhyakur Khola, Kalo Dhunga)

S.N.	Description	Test Number		Remarks
		1	2	
1	Wt. of measure + Compacted sample W1 (g)	1273.5	1260.9	
2	Wt. of cylindrical measures W2(g)	915.4	915.4	
3	Wt. of compacted sample W3(=W1-W2) g	358.1	345.5	
4	Wt. of sample passing on 2.36 mm sieve after test W4 (g)	97.56	94.62	
4	AIV= (W4/W3*100) %	27.24	27.39	
5	Average AIV (%)	27.38		

APPENDIX 13 APPROVAL LETTER FROM CENTRAL LABORATORY OF DOR



त्रिभुवन विश्वविद्यालय
इन्जिनियरिङ्ग अध्ययन संस्थान
पुल्चोक क्याम्पस
सिभिल इन्जिनियरिङ्ग विभाग

पत्र संख्या ३२/०७८/७९
०७८/७७
च.नं.

मिति .....
२०७८/०४/१७

श्री सडक विभाग
गुणस्तर, अनुसन्धान तथा विकास केन्द्र
चाकुपाट, ललितपुर ।

विषय:थेसिस प्रयोजनका लागि सहयोग गरिदिने बारे ।

उपरोक्त सम्बन्धमा यस क्याम्पसमा Msc in Transportation Engineering मा अध्ययनरत विद्यार्थीहरुका थेसिस प्रयोजनका लागि निर्माण सामग्रीहरुको तपशिल बमोजिमका टेष्टहरु गर्नुपर्ने भएकोले तहाँको ल्याव उपलब्ध गरा आवश्यक सहयोग गरिदिनु हुन अनुरोध गर्दछु ।

विद्यार्थीहरुको नाम	रोल नं.
१. अविरल आशिष	073/MSTR/251
२. पदम बहादुर मडै	073/MSTR/257
३.रिता खड्का	073/MSTR/259
४. समिर वैद्य	072/MSTR/263

गर्नु पर्ने परिक्षण

1. All aggregates test
2. All bitumen tests
3. Marshall Stability Test

Institute of Engineering
Civil Engineering
Campus

डा. प्रदिप श्रेष्ठ
विभागीय उप प्रमुख

आनन्द निकेतन, पुल्चोक, ललितपुर, नेपाल । पो.ब.नं. ११७५, काठमाडौं
फोन नं. ५५२५४७७, ५५४३०७० फयाक्स : ९७७-१-५५२५४७७

APPENDIX 14 PHOTOGRAPHS

Photograph 0-1 Location Map of Challal Ganesh Quary

Photograph 0-3 Location Map of Bhyakur Khola Quary

Photograph 0-2 Location Map of Aapghari Quary

Photograph 0-4 Location Map of Om Buddha Quary

Photograph 0-6 Aggregate Samples from Different Quarries

Photograph 0-5 Sample for CBR and Soaking CBR Samples

Photograph 0-8 Sample Preparation for Procter Test

Photograph 0-7 Stripping test sample

Photograph 0-9 Test sample for LAA