Analysis of the Aggregate Strength Variation along Different Sections of the River Basin

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ABSTRACT

Purpose: *There is high demand of aggregates material in the construction industry of Nepal. Till date, river borne aggregate material fulfills major part of the demand. Among various rivers, Biring River is one of the major rivers in Province 1. The objective of this research was to analyze the strength of Aggregate variation along the selected section river basin with a case of Biring.*
Design/Methodology/Approach: *The selected section of Biring River is about 20 Km of Arjundhara Municipality from which 6 sites along the river was selected on the basis of accessibility and deposition for aggregate sources. Lab Test for Physical properties and mechanical properties were conducted on that sample to evaluate their quality for the construction works. Also 18 cubes (3 each from 6 selected sites) were casted to evaluate their compressive strength variation. A linear relationship between the ACV, AIV and LAA value with longitudinal variation of river was established. Also the economic analysis of revenue collected by selling the aggregate of Biring River was done.*
Findings/Result: *After conducting the lab test of physical properties of aggregate, Fineness Modulus, Water Absorption and Specific Gravity were found in the range of (7.16-7.49)%, (0.72-1.15)% and and (2.616-2.712) %. A linear equation for the longitudinal variation in the LAA, AIV and ACV value was established. For a longitudinal variation equation for LAA value $y=-0.352x+37.41$ ACV value an equation $y=-0.212x+29.88$ and AIV value an equation $y=-0.0189x+27.15$ where y = Value of LAA, AIV and ACV value and x = distance in km from upstream origin point. The average compressive strength for 7 and 28 days of all cubes were found to be within standard required. The economic contribution of revenue collected by selling the river bed materials as aggregate of Biring River on the total internal revenue of Arjundhara Municipality was found to be significant that is about 30.86%.*
Originality/Value: *The study contributes that the aggregate material becomes more suitable in their hardness, toughness and strength on moving from upstream towards the downstream along the Biring river. The lower part of stream was assessed to have somewhat better quality of aggregates.*
Paper Type: *Applied Research*
Keywords: Aggregate strength variation, Upstream, Downstream, Quality, Properties of aggregates, Compressive strength, Biring river, Economic contribution**.**

1. INTRODUCTION :

Nepal having around 6000 rivers [1] which flows from higher altitude Himalaya Mountain to lower altitude *Tarai* plain land produces several river bed materials due to weathering, alteration, attrition, corrosion and hydraulic action the rock get break into smaller pieces and thus breakable pieces are

transported by the river and deposited in plain area. Therefore river is a major source of natural aggregates. Water resources not only produced different forms of energy but also carry the large sediments from the lesser and Sub- Himalayans to Terai region.

Among them, Biring River is stream, one of the important River of Jhapa District flowing in a general direction towards south from North. It is classified as class H – (Hydrographic) and Its directions are 26°34'60" N and 87°54'0" E in DMS (Degrees Minutes Seconds) or 26.5833 and 87.9 (in decimal degrees). Its UTM position is WK84 and its Joint Activity Designs reference is NG45-07. The estimate terrain elevation of Biring River above sea level is 68 metres. The Biring River is a Churia River which is originating from Siwalik and churia Hills and it is considered as one of the most vulnerable Churia river in Jhapa.

Large amount of construction materials is required For Jhapa district in the form of fine and coarse aggregates for development of infrastructure which can be extracted from the deposition of Biring River. The major infrastructure such as irrigation, roads, urban development, water supply scheme, hydropower that can be develop with in the Biring basin also demands huge amount of construction materials whose quality is of great concern.

Due to aggradation and degradation nature of river large amount of materials is transported from the upper zone to lower zone. The flowing materials deposited by the river are of high strength due to wear and tear and impact provided by the water force. Such materials are free of dust and easy on extractions. From the economic point of view such river bed materials are relatively cheap compared to crushed ones. So to know the different physical and mechanical properties of such aggregates a study of such materials is very important. Thus sediments materials are the major source of construction materials in Nepal for various infrastructure development works.

A study should be carried out to determine the quality of materials deposited at various piedmonts. Though the materials are of the same source, they might possess different characteristics due to repetitive wear and tear. Due to high current of water many impacts are faced by the river bed materials. As we go downstream part of the river the properties of aggregates may vary for same size of particles. To study those properties of aggregates is essential. This study also carried out to determine the economic contribution of the revenue collected by selling the river bed material as aggregates of Biring river Basin based on Environment consequences analysis based on the information collected from Arjundhara Municipality.

Few researches have been done in Nepal to ensure the impact of aggregate sources on compressive strength of concrete. In the examination paper distributed [2, 3, 4 & 5] scientists show the coarse aggregate source had huge variety in the compressive strength of different grade of ostensible substantial blend. They have not given any focus in the same riven at different elevation.

2. OBJECTIVES :

The overall objective of research is to analysis aggregate strength variation a selected section of Biring river basin. The specific objective of the study is:

(1) To determine the physical and mechanical characteristics of aggregates at selected section of Biring river basin and their linear relationship with longitudinal variation of river.

(2) To assure the suitability of aggregates based on compressive strength assessment of specimens prepared from selected section of Biring river basin.

(3) To determine the contribution of revenue collected by selling Aggregates of Biring river basin in the total internal source of Income of Arjundhara Municipality.

3. METHODOLOGY :

3.1 Study Area:

Different six sites were identified for sample collections on the basis of deposition of materials, accessibility to site and residential area. A complete study had been done on the physical and mechanical properties of the aggregates to find their suitability in road and concrete works. The physical properties include shape and texture, gradation, specific gravity and water absorption. The Mechanical properties include los angles abrasion test, aggregate impact value and aggregate crushing value. This study helps to make a rational decision for policymakers to identify the aggregate quarries for different sustainable development activities. Sampling of sediments was done by collecting aggregates from river banks of 5 m distance from the edge of river.

Table 1: Sample collection location along Biring river

S. N.	Spots (source)	Latitude	Longitude	Distance from origin source
1	Bhotetar	26 º 45'32" N	88 º 1'40" E	2 km
2	Jaypur sisne bridge	26 º 43'24" N	88 º 0'7" E	7 km
3	Madanpur bridge	26 º 42' 25" N	87 º 59'17" E	9.4 km
4	Fulmati bridge	26 º 41'9" N	87 º 58'51" E	11.8 km
5	DMC Causeway	26 º 39'57" N	87 º 57'23" E	15.3 km
6	Laxmipur highway bridge	26 º 38'28" N	87 º 56'13" E	19 km

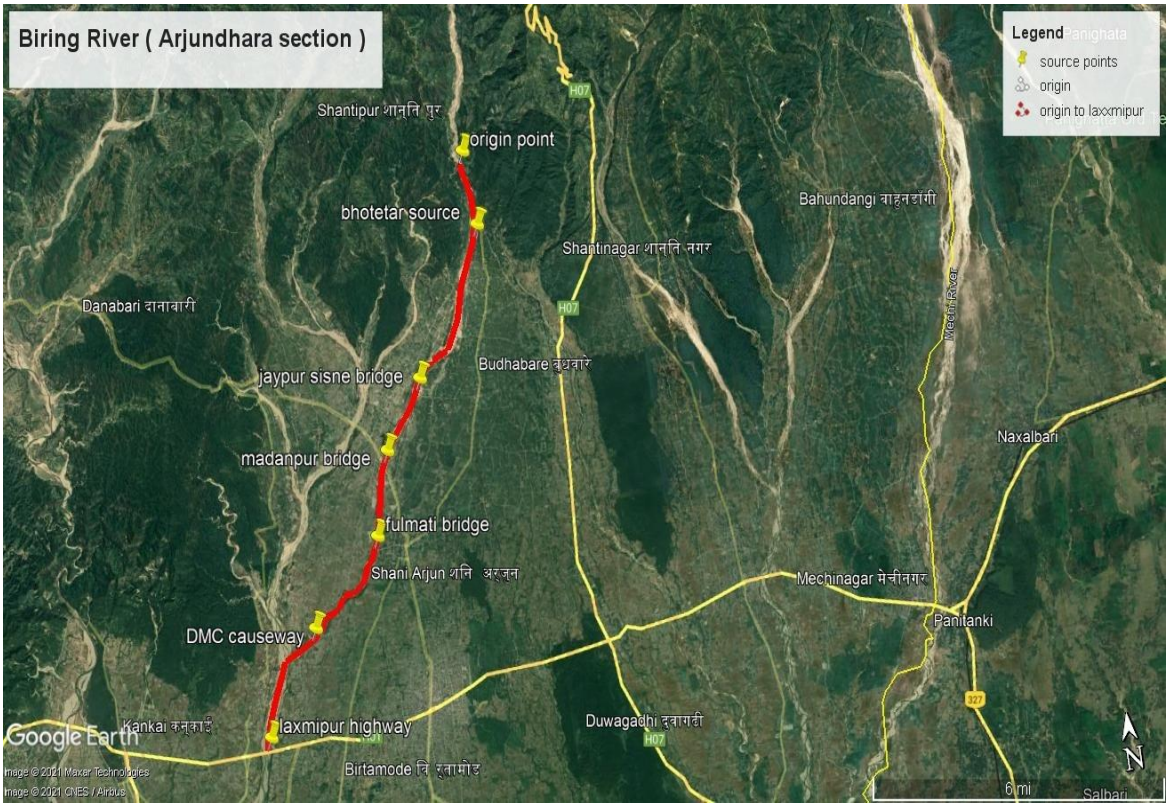

Fig. 1: Google Earth Aerial View of Sampled Site along Biring River Basin

Fine aggregates were collected from crusher of sanischare area. Alluvial/colluvium deposit comprised of boulder, cobble, gravel and sand of predominantly gneiss, quartzite and schwas. River Basin deposited gravel and private land (borrow pit) gravel and boulders for masonary works. If the gravel were screened and selected boulders were properly crushed for the Base material, coarse aggregate from concrete and SD aggregate suitable.

3.2. Research Philosophy:

The lab based diagnostic & descriptive along with field based empirical research design was adopted in this research work. Figure 2 depicts the different stages applied in the research [6].

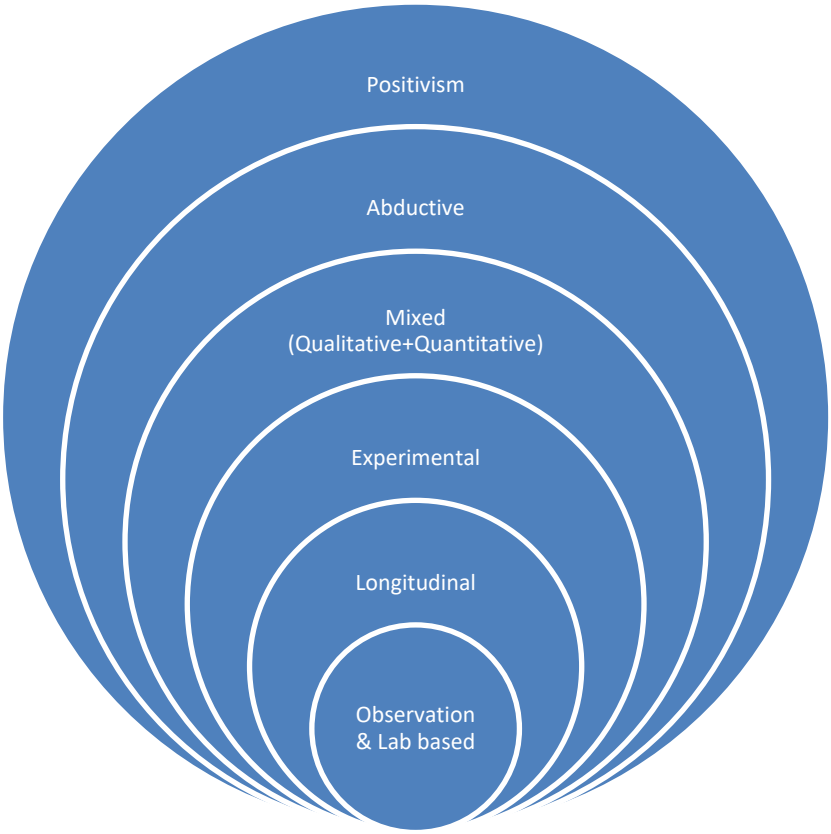

Fig. 2: Research Onion [6]

The single reality is taken from ontology part and measurable are taken from epistemology part. The overall research philosophy is Positivism is in which only "factual" obtained from observation with reliable assessment and objective interpretation. The study outcomes in these sorts of investigations are frequently apparent and quantitative.

Abduction approach for logical reasoning was followed through inductive and deductive ways. Regarding methodological choice, both qualitative as well as quantitative methods were followed. So it's a mixed method. The research strategy was experimental. As the data were collected through the different laboratory tests, this study was experimental lab-based as well as field based. The experiment was done on longitudinal time horizon. The data collection methods were observation method and lab based methods.

3.3 Sampling:

A random sampling method was used to collect the sample from each specific prefixed location to achieve the purpose of research sample adequate for different test were collected randomly at the proposed deposition. The sample was sieved and prepared at the site and then transported to the laboratory. Among the total length of river, Arjudhara Municipality section (Approx 20 Km) was considered on this study. The major basis of selection was accessibility, residential areas and deposition of materials. Though there were numerous deposition al could not be sampled because of the inaccessibility. The major considerations that were adopted for the sampling were as follows:

(1) The major deposition area was selected for sampling. It was assumed that the major deposition was covered by the study and it can be somehow generalised for gaining the concept to other site. The study of major deposition site was beneficial due to huge quantity of material aggregate would be represented.

(2) The deposition area was measured from the Google map accessed through internet at any time throughout the study period.

(3) The length of river distance between the sampling location, coordinates and relative levels were measured through the Google map and were tentative measurement and not so precise.

(4) The accuracy of the measurement of area was dependent on the accuracy obtained through the Google map at the period.

(5) The deposition area may have changed at present and may get changed in the future due to meandering of river and river flow morphology.

3.4 Data Collection:

Primary data which were collected through the lab test by the means of recording, observation, testing and measuring. Secondary source of information was collected from different source such as documents, data from government office, international journals, newspapers, books, national and international research articles, different web sites and various standard codes.

3.5 Geneal Lab Equipment for Experiment and Analysis:

3.5.1 Testing of Material

Collected materials were tested for physical as well mechanical properties as per standard testing procedures in any convenient Laboratory. Different physical test such as Gradation, Water Absorption, Specific gravity and mechanical tests such as Los Angeles abrasion test, Aggregate Impact value and Aggregate Crushing value [7-9]. The following test was carried out on the labs of Infrastructure Development Office, Jhapa. During laboratory test of concrete following factors was remained unchanged throughout the study.

- Properties of cement and Sand
- Water/cement ratio
- Use of chemical and admixtures

3.5.2 Laboratory Test:

(1) Physical Properties:

(a) Seive Analysis:

This test was performed to decide the level of various grain sizes got inside a source. The seive examination was performed to decide the conveyance of the coarser, bigger measured particles and the investigation was utilized to decide the appropriation of the better particles [7-19].

Standard Reference:

ASTMD 422-Standard Test technique for molecule size examination of source.

Importance:

The appropriation of various grain sizes influences the designing properties of source. Grain size examination gives the grain size circulation and it was expected in ordering of source.

Gear:

Balance, Set of seive, cleaning brush, seive shaker, timing gadget

Test Method:

(i) Record the heaviness of each seive as well as the lower part of dish to be utilized in the anlaysis.
(ii) Record the heaviness of the given dry source test.
(iii) Ensure that all the seive was perfect and collect them in the climbing request of strainer numbers. Cautiously empty the source test into the sieve and place the cap over it.
(iv) Spot the sieve stack in the mechanical/physically shaker and shake for 10 min.
(v) Eliminate the stack from the shaker and cautiously weight and record the heaviness of each seive with its held source. In extra, make sure to weight and record the heaviness of the base skillet with its held fine source.

(b) Fineness Modulus Test:

Fineness modulus of fine aggregates is a list number which addresses the mean size of the particles in sand. It is gotten by performing sifter examination. The combined rate held on each sifter is added and deducted by 100 gives the worth of fineness modulus. The following test procedure was adopted to obtained fineness modulus as per(“IS 2386-1 (1963)) [17-19].

(i) The sieve of different sizes was arranged in descending order.
(ii) Then the aggregate sample was poured in the top sieve and the machine was switch on and shaking of sieve was done at least 5 minutes.
(iii) After sieving, the weight of sample retained on each sieve was recorded and the cumulative weight was calculated and cumulative percentage retained was determined.
(iv) After that all the cumulative percentage values was added and was divide with 100 then the value of fineness modulus was obtained.

(c) Specific Gravity and Water Absorption Test:

Specific gravity test of aggregates is directed to quantify the strength or nature of the material. Water ingestion test is directed to decide the water holding limit of coarse and fine. The accompanying strategy was directed to decide the particular gravity and water ingestion of fine and coarse aggregate as per ("IS 2386-3 (1963).

(a) Around 2 kg of sample was taken and washed to eliminate fines.
(b) The immersion at 220C to 320C was done for 24 ± 0.5 hour.
(c) The container suspended weight in water was taken.
(d) The container was taken out from water and dried with dry spongy material for taking dry weights.
(e) The aggregate was put in a shallow plate and warmed to 100 to 1100C in the broiler for 24 ± 0.5 hours. Afterward, it was cooled in a water/air proof holder and gauged.

Apparent Specific Gravity: W4 / [W4 – (W1 - W2)]
Bulk Specific Gravity: W4 / [W3 – (W1 - W2)]

Where, Wl = Weight of saturated aggregate and basket in water
W2=Weight of basket in water
W3=Weight of saturated aggregates in air
W4=Weight of oven dry aggregates in air

Water Absorption (%) = [(W1-W2)*100]/W2

Where, W1 = Weight of saturated aggregates in air
W2 = Weight of oven dry aggregates in air

(2) Mechanical Properties:

(a) Los Angeles Abrasion Test:

This test assists with deciding the scraped area worth of course by the utilization of Los Angeles Machine. This test gives a proportion of the aggregate protection from scraped spot and effect.

Standard reference [20, 21, 22, 23, and 24]:
Department of Road, Manuals of standard Tests
Apparatus:
Los Angeles Machine, Steel Balls, WAS seives, weight Balance
Test Procedures:
(i) Evaluating was chosen to be utilized in the test with the end goal that it affirms to the reviewing to be utilized in development, to the greatest degree conceivable.
(ii) 5 kg of test was taken for reviewing A, B, C, D and 10 kg for evaluating E, F and G.
(iii) Grating charge was picked according to table 2 relying upon evaluating of total.
(iv) Put the totals and grating charge on the chamber and fix the cover.
(v) The machine is turned at the speed of 30 to 33 upset each moment. The quantity of upset s was 500 for Reviewing A, B, C and D 1000 for reviewing E, F and G. The machine ought to be adjusted and driven to such an extent that there was uniform fringe speed.
(vi) The machine was halted after the ideal number of turns and material was released to the plate.
(vii) The whole stone residue was seived on 1.7 mm WAS seive.
(viii) The material coarser than 1.7 mm size was weighted right to one gram.

Scraped area Worth = (W1-W2)/W1*100
where,
W1 = orginal weight of total
W2 = weight of total example held on 1.7 mm WAS Seive

(b) Aggregate Impact Test:

The purpose of determining the AIV was to accesses its resistance to disintegration against impact loading.

Standard Reference:
Department of Road, Manual of standard tests
Apparatus:
AIV apparatus including measuring cylinder and temping rod. WAS seive, Trays, weighting Balance, oven
Test procedures:
(i) Aggregates passing the entire of 12.5 mm and held on 10 mm WAS seive was taken.

(ii) Aggregates were filled in tube shaped measure in 3 layers by temping each layer by 25 blows. Decide the net load of the total in the action.
(iii) The mallet was raised to level of 38 cm over the upper surface and permits falling unreservedly on the example.
(iv) In the wake of exposing to 15 blows, the squashed Aggregates were seived on WAS 2.26 mm seive.

(c) Aggregate Crushing Test:

The purpose of determining the ACV was to determine the crushing strength of coarse aggregate.
Standard Reference:
Department of Road, Manual of standard tests
Apparatus:
ACV apparatus including measuring cylinder and temping rod, WAS seive, trays, weighting Balance, oven
Test procedure:
(i) Aggregates passing the whole of 12.5mm and retained on 10 mm WAS seive was taken.
(ii) Aggregates were filled in chamber measure in 3 layers by packing each layer by 25 blows. Decide the net load of total in the action.
(iii) Load was applied at uniform rate beyond what many would consider possible so that complete burden is arrived at in a short time (around 67kg/sec. The all-out load is 40 tons
After subjecting the load for 10 minutes, the crushed aggregate was seived on WAS 2.36 mm sieve [7, 19, 20].

(d) Compressive Strength Test:

Using UTM the 7 and 28 days of curing and crushing strength of the specimen was recorded.
(i) The course and fine aggregate combination was made from aggregates collected from different six sources.
(ii) The cement and aggregates mix properly and after that calculated amount of water was poured into the mix and concrete was prepared.
(iii) Then the prepared concrete was placed on oiled mould of size (150x150x150 mm^3) in at least three times one after another after compressed by using rammer manually (25 blows).
(iv) After that the cube mould was store in free area lab for 24 hr.
(v) Then after 24 hr, the mould was removed and the concrete cube was kept in water for 28 days.
(vi) After 7 and 28 days, the cube was removed from water and test was carried out on testing machine and peak load of breaking the was recorded on record book.
(vii) Finally, Compressive strength was calculated by

$$\frac{Peak\ load\ at\ which\ it\ break\ (N)}{Corss-sectional\ area\ of\ that\ cube(mm^2)}$$

Mean Compressive strength =

$$\frac{Sum\ of\ compressive\ strength\ of\ three\ sample}{3}$$

3.5.3 Analysis of Data:

Various statistical methods were used to meet the objective of the study. Data obtained as result of laboratory experiments were analysed with the statistical tool as correlation, table, charts and diagrams. The analysis was carried out using the Powerful Microsoft tool MS-Excel 2016. Regression analysis was used to established relation between strength of concrete with method of least square.

4. RESULTS AND DISCUSSION:

4.1 Physical Properties:

From the lab test of aggregates from different sources were presented below.

Table 2: Physical Properties of Aggregates

S. No.	Source of coarse Aggregate	Property	Value Obtained	DOR specification	Results

1	Bhotetar Source	Specific gravity	2.616	>2.5	Complied
		Water absorption	0.72	< 5%	Complied
		Finess Modulus	7.16	5.5-8	Complied
2	Jaypur Sisne Bridge Source	Specific gravity	2.623	>2.5	Complied
		Water absorption	0.8	< 5%	Complied
		Finess Modulus	7.32	5.5-8	Complied
3	Madanpur Bridge Source	Specific gravity	2.655	>2.5	Complied
		Water absorption	0.83	< 5%	Complied
		Finess Modulus	7.39	5.5-8	Complied
4	Fulmati bridge source	Specific gravity	2.677	>2.5	Complied
		Water absorption	0.94	< 5%	Complied
		Finess Modulus	7.42	5.5-8	Complied
5	DMC Causeway Source	Specific gravity	2.686	>2.5	Complied
		Water absorption	0.96	< 5%	Complied
		Finess Modulus	7.44	5.5-8	Complied
6	Laxmipur Highway Bridge source	Specific gravity	2.712	>2.5	Complied
		Water absorption	1.15	< 5%	Complied
		Finess Modulus	7.49	5.5-8	Complied

From the above observed value, it was found that the physical properties of the aggregates meet the criteria for the construction purpose as per DOR specification (2073) [25]. The entire source has the specific gravity greater than 2.5, Water Absorption less than 5% and fineness modulus in between 5.5-8, that is within the range of DOR specifications. The highest and the lowest value for the specific gravity and water absorption were found on Bhotetar source and Laxmipur highway bridge source respectively. A paper "An aggregate quality investigation of the Meramic River gravel" (Kadri Ercin Kasapoglu 1969) [26] also found specific gravity range (2.537-2.584), water absorption range (1.68-3.89), and fineness modulus range (6.59-7.56) of 10 different selected stations. As the specific gravity of the aggregates directly relates with the strength, the specific gravity of downstream was found to be higher than the upstream [27-30].

4.1.1 Mechanical Properties:

From the Los Angles abrasion, aggregate impact value and aggregate crushing value test of the aggregates from the different source, the obtained value was presented in the table as below.

4.1.2 Mechanical Values of Aggregates:

Table 3: Mechanical Values of Aggregates

S. N.	Location	LAA value %	AIV value %	ACV value %
1	Bhotetar source	36.4	26.7	29.4
2	Jaypur sisne bridge source	35.8	26.2	28.8
3	Madanpur bridge source	33.6	25.3	27.6
4	Fulmati bridge source	33.4	24.6	27.3
5	DMC causeway source	31.6	24.2	26.5
6	Laxmipur highway bridge source	30.9	23.7	26

From the above observed data, The LAA, AIV and ACV value was found to be highest at Bhotetar source and lowest for Laxmipur highway bridge source. The range of LAA value was (30.9-36.4) %, AIV value (23.7-36.7) %, amd ACV value (26-29.4) % which meet the criteria for the construction purpose as per DOR specification (2073). A paper "An agggregate quality investigation of the meramic river gravel" (Kadri Ercin Kasapoglu 1969) [26] also found LAA value within range (20.7-26.3) % of 10 different selected location of same Meramic river. This paper also found that LAA value goes on decreasing in lower portion of river same as Biring river Basin which indicates that the lower portion aggregate are more stronger and judged to have better strength and quality [31-35].

4.1.3 Compressive Strength:

From the lab test of aggregates from the different source were presented below.

Table 4: Compressive Strength of Aggregates

S. N.	Locations	Compressive Strength (7 days) Mpa	Compressive Strength (28 days) Mpa
1	Bhotetar source	15.43	22.69
2	Jaypur sisne bridge source	15.88	23.35
3	Madanpur bridge source	16.28	23.59
4	Fulmati bridge source	16.57	23.67
5	DMC causeway source	16.56	24
6	Laxmipur highway bridge source	17.09	24.41

From the above observed data, it was found that the cube strength of the aggregates from the Laxmipur highway bridge source have the greater strength with compressive strength of 17.09 N/mm2 in 7 days and 24.41 N/mm2 in 28 days. Since all the factor keeping constant, coarse aggregate were varied for different 6 sources in which the higher compressive strength was observed in Laxmipur highway bridge source and lowest in Bhotetar source.

4.2 Comparative Result Analysis of Mechanical Properties of Different Source:

Table 5: Comparative Result Analysis (LAA)

S. No.	Description of Works	Los Angeles Abrasion value (LAA)						
		As per specification	Bhotetar source	Jaypur source	Madanpur source	Fulmati source	DMC source	Laxmipur source
1	Granular sub-base class I and II material							
2	Granular Sub base class III and IV material							
3	Water bound macadam	Max 45%						

	for sub base			35.8%				
4	Water bound macadam for base	Max 40%	36.4%		33.6%			30.9%
5	Wet mix macadam sub base class I and II	Max 45%				33.4%	31.6%	
6	Wet mix macadam base class I and II	Max 40%						
7	Surface Dressing	Max 35%						
8	Dense Bituminous Macadam	Max 35%						
9	Penetration Macadam	Max 40%						
10	Bituminous Macadam	Max 40%						
	Result		complied	complied	complied	complied	complied	complied

From the above observed value, it was found that the LAA value of aggregates from all different six source for different kinds of road construction works meet the criteria as per DOR specification (2073) [25]. A paper "An agggregate quality investigation of the meramic river gravel" (Kadri Ercin Kasapoglu 1969) [26] also found LAA value within range (20.7-26.3) % of 10 different selected location of same Meramic river which also within the criteria limit for the construction works same as our findings.

Table 6: Comparative Result Analysis (AIV value)

S. N.	**Description of Works**	**Aggregate Impact value (AIV)**						
		As per specification	Bhotetar source	Jaypur source	Madanpur source	Fulmati source	DMC source	Laxmipur source
1	Granular sub-base class I and II material	Max 40%						
2	Granular Sub base class III and IV material	Max 45%						
3	Water bound	Max 40%						

	macadam for sub base							
4	Water bound macadam for base	Max 30%		26.2%				
5	Wet mix macadam sub base class I and II	Max 30%	26.7%		25.3%	24.6%	24.2%	23.7%
6	Wet mix macadam base class III and IV	Max 45%						
7	Surface Dressing	Max 27%						
8	Dense Bituminous Macadam	Max 27%						
9	Penetration Macadam	Max 30%						
10	Bituminous Macadam	Max 30%						
	Result		complied	complied	complied	complied	complied	complied

From the above observed value, it was found that the AIV value of aggregatess from all different six source for different kinds of road construction works meet the criteria as per DOR specification (2073) [25]. A paper "An agggregate quality investigation of the meramic river gravel" (Kadri Ercin Kasapoglu 1969) [26] also found AIV value within range of 10 different selected location of same Meramic river which also within the criteria limit for the construction works same as our findings.

Table 7: Comparative Result Analysis (ACV value)

S. N	Description of Works	Aggregate crushing value (ACV)						
		As per specification	Bhotetar source	Jaypur source	Madanpur source	Fulmati source	DMC source	Laxmi pur source
1	Granular sub-base class I and II material	Max 40%						
2	Granular Sub base class III and IV material	Max 45%						

3	Water bound macadam for sub base	Max 40%						
4	Water bound macadam for base	Max 30%						
5	Wet mix macadam sub base class I and II	Max 30%		26.2%				
6	Wet mix macadam base class III and IV	Max 45%	26.7%		25.3%	24.6%	24.2%	23.7%
7	Surface Dressing	Max 27%						
8	Dense Bituminous Macadam	Max 27%						
9	Penetration Macadam	Max 30%						
10	Bituminous Macadam	Max 30%						
	Result		complied	complied	complied	complied	Complied	Complied

From the above observed value, it was found that the ACV value of aggregates from all different six source for different kinds of road construction works meet the criteria as per DOR specification (2073) [25]. A paper "An agggregate quality investigation of the meramic river gravel" (Kadri Ercin Kasapoglu 1969) [26] also found ACV value within range of 10 different selected location of same Meramic river which also within the criteria limit for the construction works same as our findings [36].

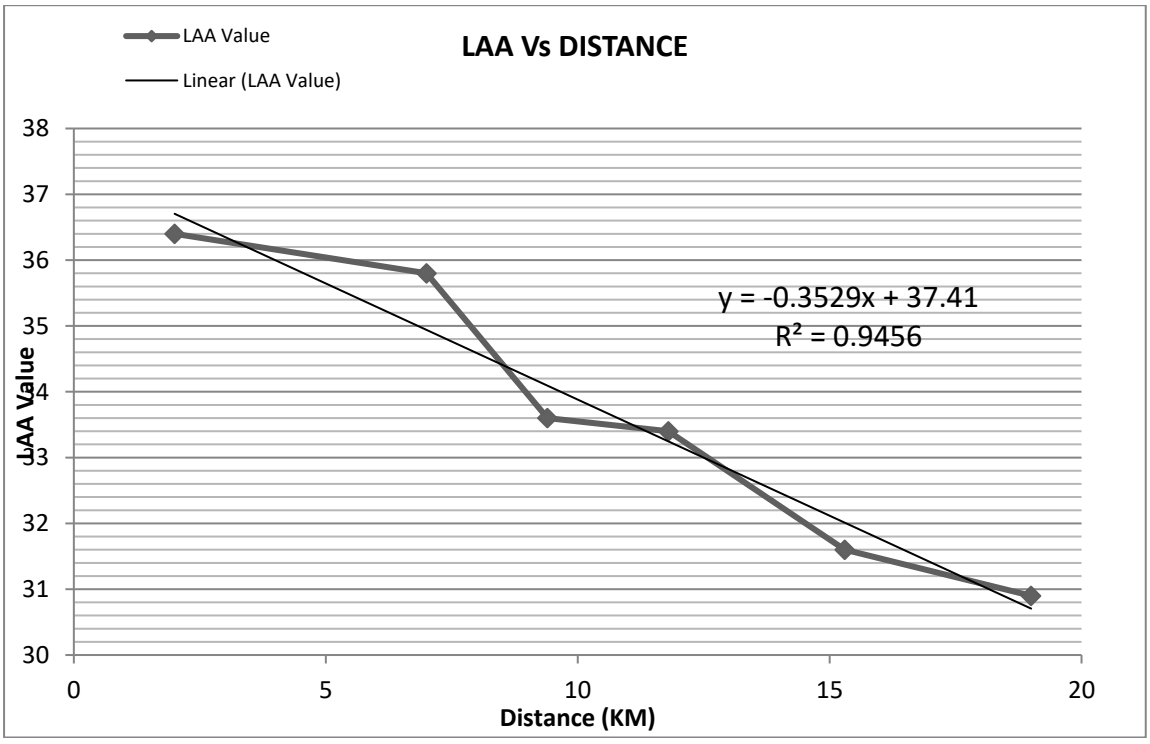

Fig. 3: Graphical representation of LAA and Distance (KM)

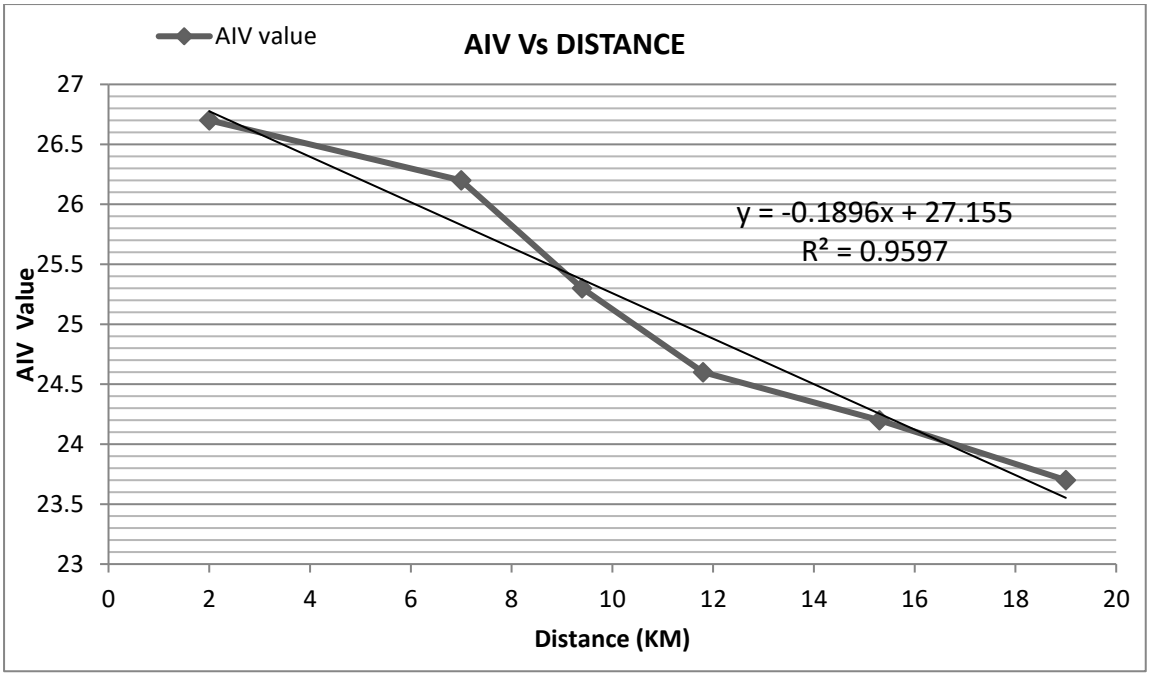

Fig. 4: Graphical representation of AIV and Distance (KM)

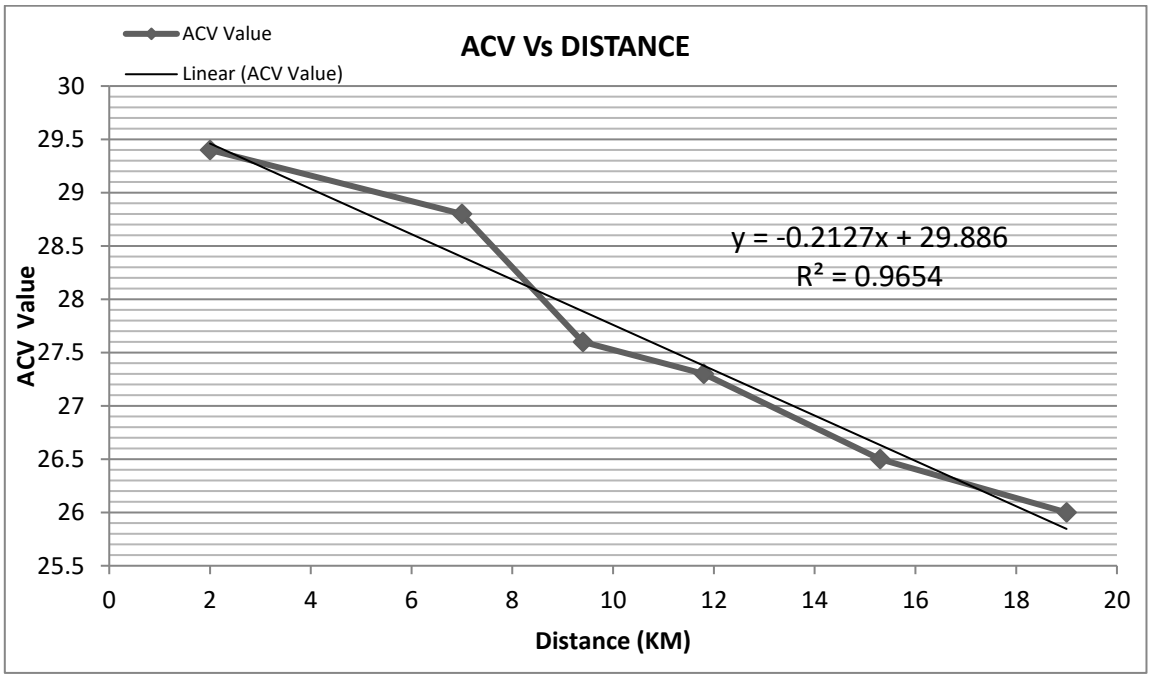

Fig. 5: Graphical representation of ACV value and Distance (KM)

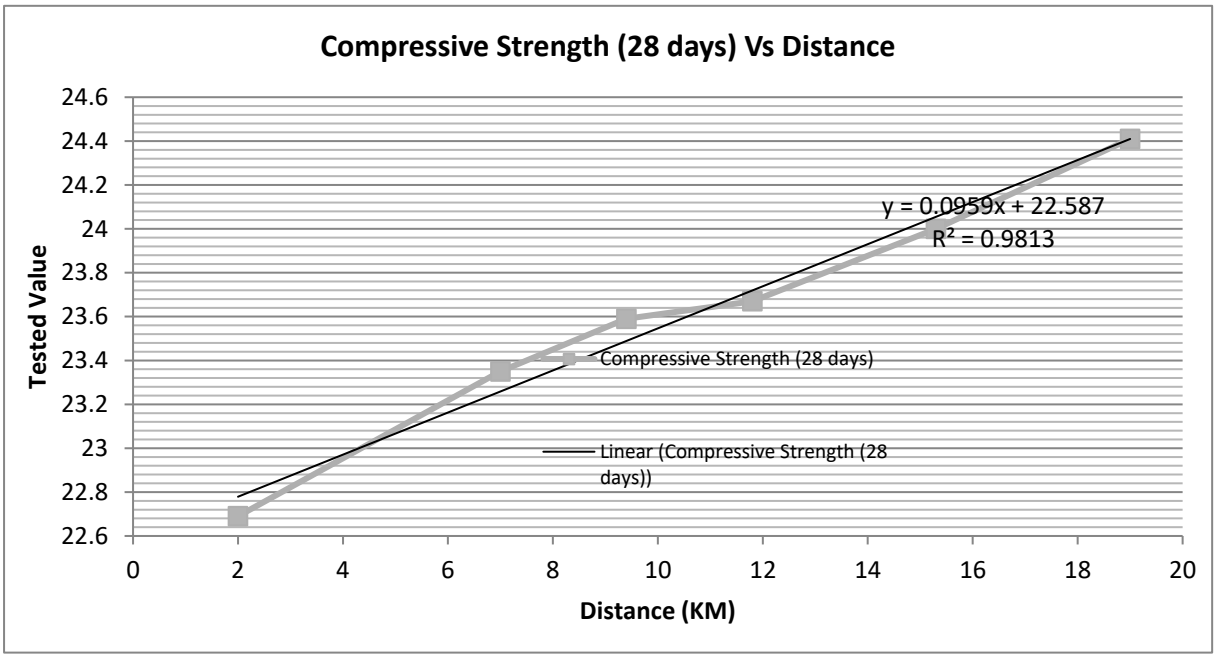

Fig. 6: Graphical representation of compressive strength (28 days) and Distance (KM)

From the graph it was found that the abrasion, impact and crushing value of the aggregates goes on deccreasing downwards due to wear and tear action of the river. The value compressive strength of cube goes on increasing using the aggregates of lower portion of Biring river basin. As the highest value of LAA, AIV and ACV was found on the Bhotetar source whereas the lowest value was obtained for Laxmipur highway bridge source. The lower part of Biring waterway Bowl is found to have somewhat better strength and nature of total. A paper "An agggregate quality examination of the meramic waterway rock" (Kadri Ercin Kasapoglu 1969) [26] likewise concentrated on various 10 station of same meramic stream and found that the lower piece of meramic waterway have generally better nature of total for development same as our review.

Different linear equation developed where x = distance from the origin source

for abrasion value

$y = -0.352x + 37.41$ ..... (i)

for impact value

$y = -0.189x + 27.15$ ..... (ii)

for crushing value

$y = -0.212x + 29.88$ ..... (iii)

for 28 days compressive strength

$y = 0.095x + 22.58$ .....(iv)

4.3 Economic Contribution of Biring River aggregate Extraction:

In Fiscal year 2077/78, Arjundhara Municipality had invitation of Bid to sell the aggregates of Biring River in two Package according to the approved IEE report.

Table 8: Invitation of Bid to sell the aggregates of Biring River in two Packages according to the approved IEE report

S. N.	Contract No.	Abstract Amount aggregate (Cum) according to Approved IEE	Minimum Bid Amount (without VAT)
1	AM/IR/04/077/78 (Package 1)	54000 cum	1,02,18,395/- (One crore two lakhs eighteen Thousand three hundred ninty five only.)

2	AM/IR/05/077/78 (Package 2)	39050 cum	67,58,496.41/- (Sixty seven Lakhs fifty eight thousand four hundred ninty six and forty one paisa only)
	Total:	93050 cum	1,69,76,891.41/- (One crore sixty nine lakhs seventy six thousand, eight hundred ninty one and forty one paisa only)
	Forecasted Internal source of Income for Fiscal Year 2077/78		5,50,00,000/- (Five crore fifty lakhs only)
	Weightage of the Income generated from extraction of Biring River to the total predicted Internal source of Income	(16976891.41/55000000)*100 % = 30.86%	-

For Arjundhara Municipality, the major portion of the internal source of Income was found to be from income generated from extraction of the river aggregates of Biring River basin. The weightage of Income generated to total predicted internal source of Income of Arjundhara Municipality was about 30.86%.

5. FINDINGS :

(1) The specific gravity of the aggregates ranges from 2.616 to 2.712 within the satisfactory range.
(2) The water absorption value for different sources was found to be varied from 0.72 % to 1.15% which is satisfactory.
(3) The average percent of LAA value for the aggregate samples is 33.62% which is satisfactory according to DOR specification for construction aggregates. Aggregate sample from Bhotetar source had the most abrasion loss (36.40%) but it was still below the maximum allowable loss specified by DOR, which is 45% by weight for coarse aggregates. Each of the samaple tested had an LAA value below this limit. Sample of Laxmipur highway bridge source had the lowest value (30.9%) of all those tested. The variation of the LAA value was from 30.9% to 36.40%. The general equation of $y = -0.3526x + 37.41$ was obtained where x = distance from origin source.
(4) The average value of AIV for the aggregates sample is 25.12% which is satisfactory according to DOR specifications for construction aggregates. Aggregate of Bhotetar source has the most impact loss (26.70%), but it was still below the maximum allowable loss specified by DOR, which is 30% by weight for the coarse aggregates. Each of the samples tested had AIV value below this limit. Sample of Laxmipur highway bridge source had the lowest AIV value (23.70%) of all those tested. The variation of the AIV was from 23.70% to 26.70%.The general equation of $y = -0.189x + 27.15$ was obtained, where x = distance from origin source.
(5) The average value of ACV for the aggregate samples is 27.60% which is satisfactory according to the DOR specification for construction aggregates. Aggregates sample from the Bhotetar had the most crushing loss (29.40%) but still below the maximum allowable loss specified by DOR, which is 30% by weight for coarse aggregates. Each of the samples tested had the ACV below this limit. Sample of the Laxmipur highway bridge source had the lowest ACV (26.0%) of those all tested. the variation of ACV value was from 26% to 29.4%. The general equation of $y = -0.212x + 29.88$ was obtained, where x = distance from origin source.
(6) The average percent of the compressive strength of the cube casted from the different sample was found to be 23.62 N/mm2 for 28 days. The highest compressive strength is from the Laxmipur highway bridge source (24.41 N/mm2) with the lowest value of Bhotetar of 22.69 N/mm2.
(7) The weightage of source of Income generated by extraction of the aggregates of the Biring river basin to total internal source of Income of Arjundhara Municipality was about 30.86%.

6. CONCLUSION :

(1) The physical and mechanical properties of aggregates of Biring river Basin was found to be satisfactory in all six selected section of Biring river Basin. The physical and mechanical strength of aggregates goes on increasing along going from upstream to downstream of Biring river. The lower portion of river have relatively better quality of aggregate.
(2) The compressive strength of the cubes casted from all six selected section of Biring river basin was satisfactory and with the standard required. The compressive strength of cube prepared by aggregate of lower portion of river have relatively grater compressive strength than upper portion.
(3) The source of Income generated by extraction of the aggrgates of the Biring river basin has significant contribution in the total internal source of Income of Arjundhara Municipality.

7. RECOMMENDATIONS :

The test results were obtained through the Laboratory test from the collected samples from different six locations along the Biring river Basin. It was found that the aggregate from all the source complied the minimum required value regarding the strength for the construction work under the scope of this study. Hence it is recommended to use the aggregate material from Biring river from the study area for the construction of any construction works. The strength of aggregate increases toward downstream of river so when high strength of concrete is required aggregate from downstream source can be used.
The financial status of any local government was strong if only its internal source of Income is high. This source can be used in different development works initiated by the local government for the betterment of the people and the society. If extraction of aggregates from Biring river basin can be done scientifically then internal source of Income can be increased.

8. LIMITATIONS OF STUDY:

There are many variables that control the strength of concrete. Among them cement content and its properties, properties of fine aggregates, water content and its property, type of admixture and its dosage, degree and method of compaction and duration of curing which directly affects the strength of concrete. These factors are not considered.
Among the total length of Biring river only Arjundhara Section (Approx 20 KM) is considered since the upper slope are very steep and rare in deposition. The sampling was done from outside the water body from the deposited stock. The chemical properties of the aggregate are not considered for the research study.

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