ENGINEERING MATERIALS (SESSIONAL)

CE-204

EXPERIMENT NO.- 2

a) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine - **ASTM C131**

b) Method for Determination of Aggregate Impact Value (AIV) – **BS 812-112**

2 (a) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

INTRODUCTION

- Aggregates used in highway pavements should be hard and resist wear due to the polishing effects of traffic and the internal abrasive effects of repeated loadings.

- Sizes of coarse aggregate smaller than 1.5 inch (37.5 mm) for resistance to degradation using the Los Angeles testing machine
- Indicator of the relative quality or competence of various sources of aggregate having similar mineral compositions.
- The resistance to abrasion and impact is determined simultaneously.
- Degradation of mineral aggregates resulting from combined actions including abrasion or attrition, impact, and grinding in a rotating steel drum containing a specific number of steel spheres.

- As the drum rotates, a shelf plate picks up the sample and the steel spheres, carrying them around until they are dropped to the opposite side of the drum, creating an impact- crushing effect, and the cycle is repeated.
- After the prescribed number of revolutions, the contents are removed from the drum and the aggregate portion is sieved to measure the degradation as percent loss.

APPARATUS

Figure: Los Angeles Abrasion Machine

APPARATUS CONT'D

Los Angeles Machine:

- Hollow steel cylinder, with a wall thickness of not less than 12.4 mm closed at both ends, conforming to the dimensions shown in Fig. 1, having an inside diameter of 711 ± 5 mm (28 ± 0.2 in), and an inside length of 508 ± 5 mm (20 ± 0.2 in).
- An opening in the cylinder shall be provided for the introduction of the test sample.
- A suitable, dust-tight cover shall be provided for the opening with means for bolting the cover in place.
- A removable steel shelf extending the full length of the cylinder and projecting inward 89 ± 2 mm (3.5 ± 0.1 in) shall be mounted on the interior cylindrical surface of the cylinder

Sieves:

Balance:

Charge:

The charge shall consist of steel spheres averaging approximately 46.8 mm in diameter and each having a mass between 390 and 445 g. The charge, depending upon the grading of the test sample shall be as follows:

Grading	Number of Spheres	Mass of Charge (gm)
A	12	5000 ± 25
B	11	4584 ± 25
C	8	3330 ± 20
D	6	2500 ± 15

SAMPLING

Test Sample Preparation

- Wash and oven dry the sample at 110 ± 5°C (230 ± 9°F) to constant mass
- separate into individual size fractions, and recombine to the grading of Table 2.1 most nearly corresponding to the range of sizes in the aggregate as furnished for the work.
- Record the mass of the sample prior to test to the nearest 1 g.

TABLE 2.1 GRADINGS OF TEST SAMPLE

Sieve Size (square openings)		Mass of indicated Sizes, gm			
Passing	Retained on	Grading			
		A	B	C	D
37.5 mm (1.5”)	25.0 mm (1”)	1250 ± 25	----	----	----
25.0 mm (1”)	19.0 mm (0.75”)	1250 ± 25	----	----	----
19.0 mm (0.75”)	12.5 mm (0.5”)	1250 ± 10	2500 ± 10	----	----
12.5 mm (0.5”)	9.5 mm (0.375”)	1250 ± 10	2500 ± 10	----	----
9.5 mm (0.375”)	6.3 mm (0.25”)	----	----	2500 ± 10	----
6.3 mm (0.25”)	4.75 mm (No. 4)	----	----	2500 ± 10	----
4.75 mm (No. 4)	2.36 mm (No. 8)	----	----	----	5000 ± 10
Total		**5000 ± 10**	**5000 ± 10**	**5000 ± 10**	**5000 ± 10**

PROCEDURE

- Place the test sample and the charge in the Los Angeles testing machine and rotate the machine at a speed of 30 to 33 r/min for 500 revolutions.
- After the prescribed number of revolutions, discharge the material from the machine and make a preliminary separation of the sample on a sieve coarser than the 1.70-mm (No. 12) sieve.
- Sieve the finer portion on a 1.70-mm sieve in a manner conforming to ASTM C 136 .
- Wash the material coarser than the 1.70 mm (No. 12) sieve and oven-dry at 110 ± 5°C (230 ± 9°F) and determine the mass to the nearest 1 gm.

SAMPLE DATA SHEET

Data Sheet

Sample Taken	=	gm
Sample Retained on No. 12 Sieve	=	gm
Loss of Sample	=	gm

LOS ANGELES ABRASION VALUE (LAAV):

$$= \frac{Loss\ of\ sample}{Sample\ Taken} \times 100\ \%$$

$$= \text{————} \times 100\ \%$$

$$= \quad \%$$

SAMPLE TYPE:

CALCULATION

- Calculate the loss (difference between the original mass and the final mass of the test sample) as a percentage of the original mass of the test sample.
- Report this value as the percent loss.

REPORT

The Report shall include the following information:

- Identification of the aggregate as to source, type, and nominal maximum size
- Grading designation from Table 2.1 used for the test
- Loss by abrasion and impact of the sample expressed to the nearest 1% by mass.

SHORT QUESTIONS

1. What is the significance of Abrasion of Aggregates?
2. Why Los Angeles Abrasion Test is most commonly accepted and used?
3. How is the abrasive charge selected for Los Angeles Abrasion Test? Write down the no. of spheres & weight of charges for different cases.
4. What is the significance of Los Angeles Abrasion Test?
5. What is the rotational speed & no. of total revolutions for this test?

2 (b) Method for Determination of Aggregate Impact Value (AIV)

BS 812-112

INTRODUCTION

- Toughness is the property of a material to resist impact.
- Due to traffic loads, the road stones are subjected to the pounding action or impact and there is possibility of stones breaking into smaller pieces.
- the resistance of the stones to fracture under repeated impacts may be called an impact test for road stones.

INTRODUCTION CONT'D

- The aggregate Impact value gives a relative measure of the resistance of an aggregate to sudden shock or impact, which in some aggregates differs from its resistance to a slowly applied compressive load.
- With aggregate of-impact value higher than 30 the result may be anomalous.
- Also, aggregate sizes larger than 14 mm are not appropriate to the aggregate impact test.
- The standard aggregate impact test shall be made on aggregate passing a 14.0 mm BS test sieve and retained on a 10.0 mm BS test sieve.

INTRODUCTION CONT'D

- If required, or if the standard size is not available, smaller sizes may be tested but owing to the non-homogeneity of aggregates the results are not likely to be the same as those obtained from the standard size.
- In general, the smaller sizes of aggregates will give a lower-impact value but the relationship between the values obtained with different sizes may vary from one aggregate to another.

APPARATUS

Figure: Aggregate Impact Test Machine

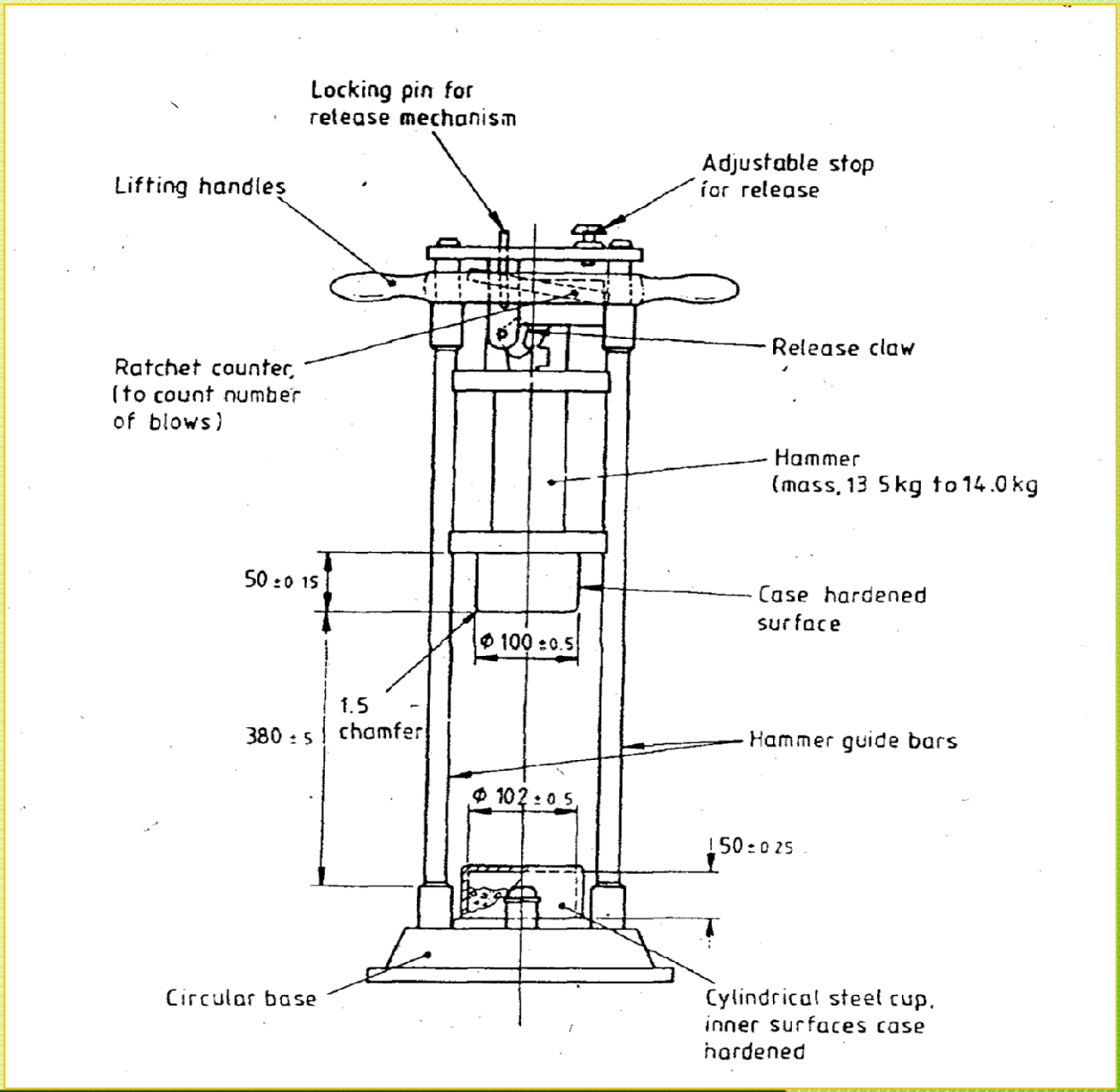

Figure: Aggregate Impact Test Machine

IMPACT TESTING MACHINE

An impact testing machine should complying with the following:

- Total mass not more than 60 kg not less than 45 kg.
- The machine shall have a circular metal base "weighing between 22 kg and 30 kg".
- With a plane lower surface of not less than 300 mm diameter, and shall be supported on a level and plane concrete or stone block or floor at least 450 mm thick.
- The machine shall be prevented from rocking either by fixing it to the block or floor or by supporting it on a level and plane metal plate cast into the surface of the block or floor.
- A cylindrical steel cup having an internal diameter of 102 mm and an internal depth of 50 mm.

IMPACT TESTING MACHINE CONT'D

- The walls shall not be less than 6 mm thick and the inner surfaces shall be case hardened.
- A metal hammer weighing 13.5 kg to 14.0 kg the lower end of which shall be cylindrical in shape, 100 mm diameter and 50 mm long, with a 1.5 mm chamfer at the lower edge, and case hardened.
- Means for raising the hammer and allowing it to fall freely between the vertical guides from a height of 380 ± 5 mm on to the test sample in the cup, and means for adjusting the height of fall within 5 mm.
- Means for supporting the hammer whilst fastening or removing the cup.

APPARATUS

- **ASTM test sieves** of aperture size 12.5 mm, 9.5 mm and 2.36 mm, for a standard test.
- **A cylindrical metal measure** of sufficient rigidity to retain its form under rough usage and with an internal diameter of 75 ± 1 mm and an internal depth of 0.50 ± 1 mm
- **A straight metal tamping rod** of circular cross section, 10 mm diameter, 230 mm long, rounded at one end.
- **A balance** of capacity not less than 500 g, and accurate to 0.1 g.

PREPARATION OF THE TEST SAMPLE

- Aggregate passing 14.0 mm BS test sieve and retained on a 10.0 mm BS test sieve
- For smaller sizes the aggregate shall be prepared in a similar manner using the appropriate sieves given in Table 1.
- The quantity of aggregate sieved out shall be sufficient for two tests.
- The aggregate shall be tested in a surface-dry condition.
- If dried by heating, the period of drying shall not exceed 4h, the temperature shall not exceed 110°C and the samples shall be cooled to room temperature before testing.

Table 1: Particulars of BS test sieves for testing standard and non-standard sizes of aggregates

Sample size	Nominal aperture sizes of BS test sieves complying with the requirements of BS 410 (full tolerance)		
	For sample preparation		For separating fines
	Passing	Retained	
Non – standard	28.0 mm	20.0 mm	5.00 mm
	20.0 mm	14.0 mm	3.35 mm
Standard	14.0 mm	10.0 mm	2.36 mm
Non – standard	10.0 mm	6.30 mm	1.70 mm
	6.30 mm	5.00 mm	1.18 mm
	5.00 mm	3.35 mm	0.85 mm
	3.35 mm	2.36 mm	0.60 mm

NOTE: *Aggregate sizes larger than 14.0 mm are not appropriate to the aggregate impact test.*

PREPARATION OF THE TEST SAMPLE

- The measure shall be filled with the aggregate by means of a scoop, the aggregate being discharged from a height not exceeding 50 mm above the top of the container.
- The aggregate shall then be tamped with 25 blows of the rounded end of the tamping rod, each blow being given by allowing the tamping rod to fall freely from a height of about 50 mm above the surface of the aggregate and the blows being evenly distributed over the surface.
- the surplus aggregate removed by rolling the tamping rod across, and in contact with, the top of the container, any aggregate which impedes its progress being removed by hand and aggregate being added to fill any obvious depressions.
- The net mass of aggregate in the measure shall be recorded (mass A) and the same mass used for the second test.

TEST PROCEDURE

- Fix the cup firmly in position on the base of the machine and place the whole of the test sample in it and compact by a single tamping of 25 strokes of the tamping rod as above.
- Adjust the height of the hammer so that its lower face is 380 ± 5 mm above the upper surface of the aggregate in the cup and then allow it to fall freely on to the aggregates.
- Subject the test sample to a total of 15 such blows, each being delivered at an interval of not less than 1 sec.
- No adjustment for hammer height is required after the first blow.
- Then remove the crushed aggregate by holding the cup over a clean tray and hammering on the outside with a suitable rubber mallet until the sample particles are sufficiently disturbed to enable the mass of the sample to fall freely on to the tray.

TEST PROCEDURE

- Transfer fine particles adhering to the inside of the cup and the underside of the hammer to the tray by means of a stiff bristle brush.
- Sieve the whole of the sample in the tray, for the standard test, on the 2.36 mm BS test sieve until no further significant amount passes in 1 minute.
- When testing sizes smaller than the standard separate the fines on the appropriate sieve given in the 'for separating fines' column in Table 1.
- Weigh the fractions passing and retained on the sieve to an accuracy of 0.1 g (mass B and mass C respectively) and if the total mass B+C is less than the initial mass (mass A) by more than 1 g, discard the result and make a fresh test.
- Repeat the whole procedure starting from the beginning using a second sample of the same mass as the first sample.

SAMPLE DATA SHEET

Data Sheet

Observation No.	1	2
Wt. of Sample, (Surface dry) $\boldsymbol{A}$, gm		
Wt. of material retained on 2.36 mm sieve, $\boldsymbol{C}$, gm		
Wt. of material passing 2.36 mm sieve, $\boldsymbol{B} = (\boldsymbol{A} - \boldsymbol{C})$, gm		
Aggregate Impact Value (AIV) $= (\boldsymbol{B}/\boldsymbol{A})\ \boldsymbol{x}\ \boldsymbol{100}\%$ (to the first decimal place)		

Average Aggregate Impact Value (AIV) =
(To the nearest whole number)

CALCULATION

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

$$\boldsymbol{Aggregate\ Impact\ Value\ (AIV) = \frac{B}{A} \times 100}$$

Where,

A is the mass of surface-dry sample (g);

B is the mass of fraction passing the sieve (2.36 mm) for separating the fines (g)

The mean of the two results shall be reported to the nearest whole number as the aggregate impact value

REPORT

The Report shall include the following information:

- Identification of the aggregate as to source, type, and nominal maximum size
- Grading designation from Table 2.1 used for the test
- Loss by abrasion and impact of the sample expressed to the nearest 1% by mass.

SHORT QUESTIONS

1. What is Aggregate Impact Value?
2. Why Aggregate Impact Value of road stones is important?
3. What are the applications of Aggregate Impact Value?
4. Aggregate impact value material A is 15 and that of B is 20. Which one is better for surface course? Why?