



2014

FINAL INTERNSHIP REPORT



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TCDsco

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In addition to this, my thanks goes out to all TCDsco employees especially to Ato behailu and w/ro sosina getachew for their continued help in providing counsel as well as technical support.



iv. Abstract

This is a report that is written to give an account to my internship general overview. The report contains sections. The first section is an introduction to the report. The second section is general information on the company's background and achievements. The third section is about my personal experience I conceived during my stay in the contractor class and consultant as well as outlines my share of work in both class. The forth section states what I gained during the internship. The last section contains reference for the report.



v. Declaration of the Student & Approval of the Mentor

Student name yaekob getahun

Signature_____

Date _____

District Supervisor Name _

Signature _____

Date _____

Mentor name _ Michael

Signature _____

Date _____

I declare that this report is my own work. I composed this report based on my experience, observations and achievements I have gained during my internship period.



VI. EXECUTIVE SUMMARY

Now a days construction is the most undertaking policy in Ethiopia. TCDSCO is the leading laboratory and design companies in the country, thus tests for construction purpose as well as design of the most important highways has been done in this company. Geotechnical investigation for giant structures such as dams, bridges has been successfully achieved.

According to the program of Addis Ababa institute of technology I have been working my internship in this company for the last four months from October to February. During this period I was working in the sections provided by the company, which are soil section, asphalt section, concrete section and design section.

In my opinion I was lucky to work in this company that I become familiar with most of laboratory sections which are the milling stone for any construction. Besides I become familiar with the latest technologies (software's) which are helpful for design of structures.

Generally; during the internship period I have developed & gained different skills, attitude & knowledge of properties of materials helpful for construction as well as design of structures, and of course I gained basic knowledge to reach on conclusion of materials from conducted tests.



1. Brief History of transport construction design share company

Transport Construction Design Share Company (TCDsco) is a full-fledged state owned consulting firm that deals with the Design and Construction supervision of Roads, Bridges and Airports. The company is established in August 1987 before its establishment as an independent consulting firm TCDsco had been a division under Ethiopian Roads Authority.

The main purposes of its establishment are:

- ❖ To engaged in activities of surveying and design of transportation works.
- ❖ To engage in construction materials testing, and Geotechnical investigation for buildings, Dams, etc.
- ❖ To render consultancy services in construction supervision and contract Administration.
- ❖ To engaged in any other related activities necessary for the attainment of its purpose.

TCDsco is located at Addis Ababa: Behind Ethiopian Road Authority (ERA). The company has more than 40 years of experience particularly in photogrammetry, surveying, design, materials investigation and testing and, construction supervision with regard to roads, bridges and airports. It has also acquired substantial experience in design of Buildings, west works and other civil Engineering works. The company is currently having 440 and above staff members.



Vision of the share company

To be one of the leading international construction consultants in the field of civil works.



Mission of the Share Company

To render Design and Construction Supervision Consultants service for civil works with care, diligence and in strict accordance professional standards that ensure satisfaction of clients.

1.1 Major services /Activities

The major activities of the company are delegated among the following three functional and two support giving departments:-

- ❖ Contract formulation and Business Department
- ❖ Design Department
- ❖ Construction supervision Department



- Service Delivery improvement Department
- Administration and Business Department

i. Contract Formulation and Business Development Department

- ✓ Strategic planning of the company
- ✓ Preparation of technical and financial proposal and contract documents
- ✓ Preparation of Tender Documents, Engineering Cost Estimates
- ✓ Tendering construction contract and Analysis of bids
- ✓ Monitoring the progress of projects
- ✓ Business Environment Assessment
- ✓ Documentation and Library service.

ii. Design Department

I. Survey division

Surveying division is mainly responsible for:-

- ❖ Photogrammetry and survey works including aerial photo Reproductions,
- ❖ Location survey
- ❖ Drainage survey
- ❖ Data processing for Design and
- ❖ Topographic Map and Hydrographic studies

II. Geotechnical division

The major activities of this division includes,

a. Filed investigation

- ❖ Traffic survey
- ❖ Soil and material investigation
- ❖ Pavement design
- ❖ Pavement Evaluation and Land Slide Investigation
- ❖ Geotechnical investigation for Bridges, Dam-sites, Buildings and other exploratory works

b. Material Testing

- ❖ Laboratory testing of soil, aggregates, concrete, asphalt and related construction materials and
- ❖ Asphalt and concrete mix-design

III. Design division

The major services rendered by this division are:-



a) Routes and facilities design

- ❖ Geometric design of roads
- ❖ Geometric design of Air ports and
- ❖ Geometric design of other facilities
- ❖ The design of most of roads and most airports and airfields of the country are the result of the rich experience of the design staff of TCDsco.

b) Bridges and structural Designs

- ❖ Design of Bridges, Buildings, water works
- ❖ Design of other types of structures

The biggest bridges such as Baro river, jemariver, Tekeze river and Bashilo river bridges which are spanning 260 and above are designed by TCDsco ,with Bashilo river Bridge spanning 338m.

Construction supervision Department

The major activities of construction supervision Department are:-

- ❖ Construction supervision service for Rural, Asphalt and Feeder roads, Bridges and Airports.
- ❖ Quality control in accordance with the design specification
- ❖ Schedule and cost control
- ❖ Contract Administration
- ❖ Checking and approval of payment certificate for contractors
- ❖ Claims management
- ❖ Preparation of reports

1.2 Equipment's of the company

I. Survey equipment's

In TCDSCO main surveying equipment's are Total Station, G.P.S., theodolites, diatomite, levels and other conventional surveying equipment's.

II. Geotechnical Investigation Equipment

- ❖ Wire line Truck Mounted Rig capable of angle drilling. Maximum core recovery and packer tests, etc.
- ❖ Dynamic Con penetration Apparatus
- ❖ Benkelman Deflection Beam

III. Construction Material Laboratory Equipment



- ❖ Soil and Chemical Testing Laboratory testing apparatus
- ❖ Marshal testing machine for Asphalt concrete Mix-design
- ❖ Computerized CBR machine
- ❖ Computerized Traxial, Consolidation Direct/Residual shear and CBR machine with Accessories
- ❖ Mortar mixer
- ❖ Computerized compressive strength Testing Machine
- ❖ Brazilian Tensile strength testing machine
- ❖ Rock core and Mortar strength Testing Machine
- ❖ Loss Angels Abrasion Machine
- ❖ Viscosity Tester

➤ **Library facility**

The company has a well-organized Library with a collection of all round reference books, in particular with manuals and specification that are applied in the design of civil Engineering works.

1. 3. Major customers of the company

The following are few customers of the company while I was in the company.

- ✓ ERA
- ✓ Sunshine Construction
- ✓ AACRA
- ✓ AdamaAwash highway project
- ✓ Keangnam interprise.
- ✓ Air field jigjiga.
- ✓ SaTcon
- ✓ CGC

1.4 Over all organization of the company

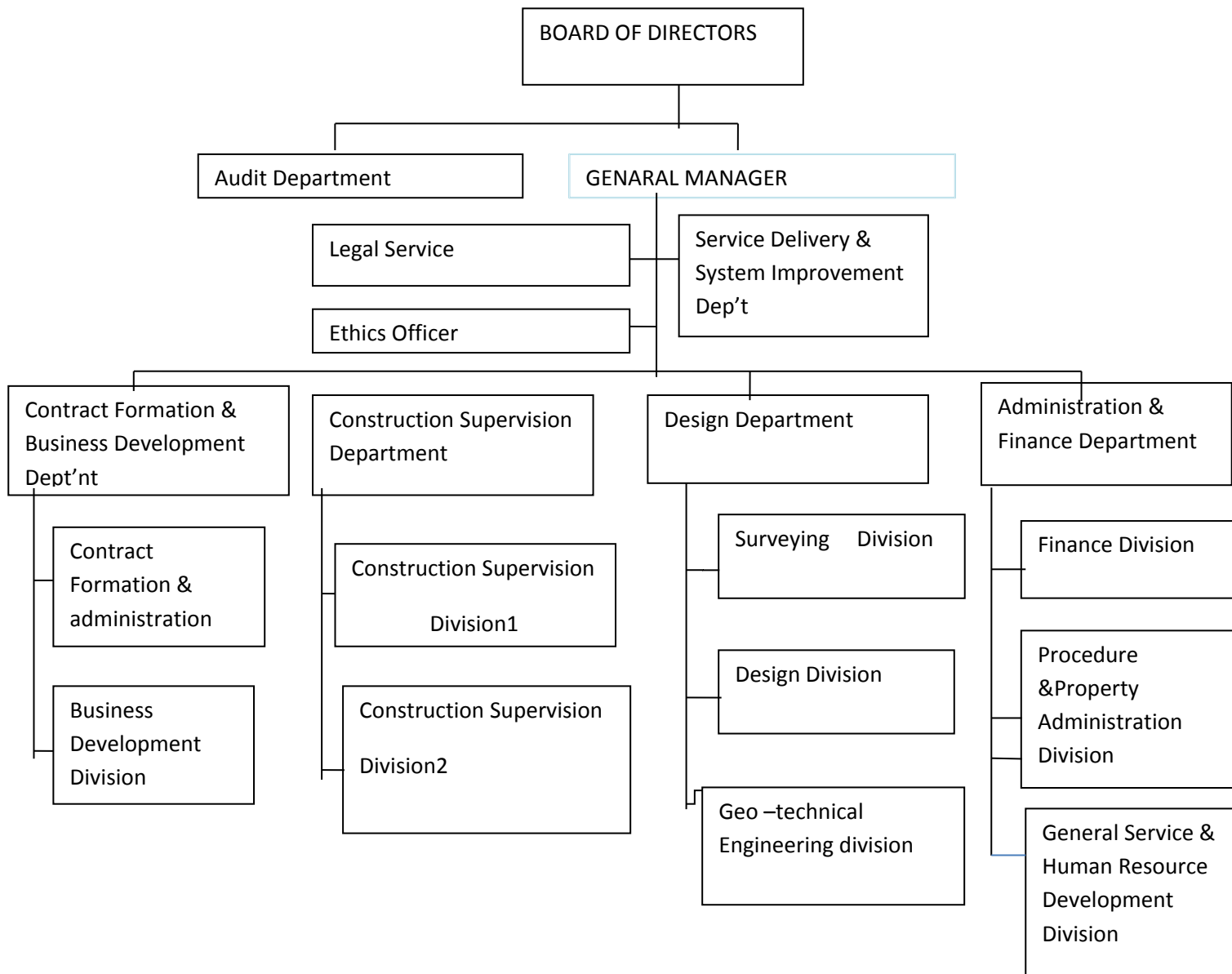
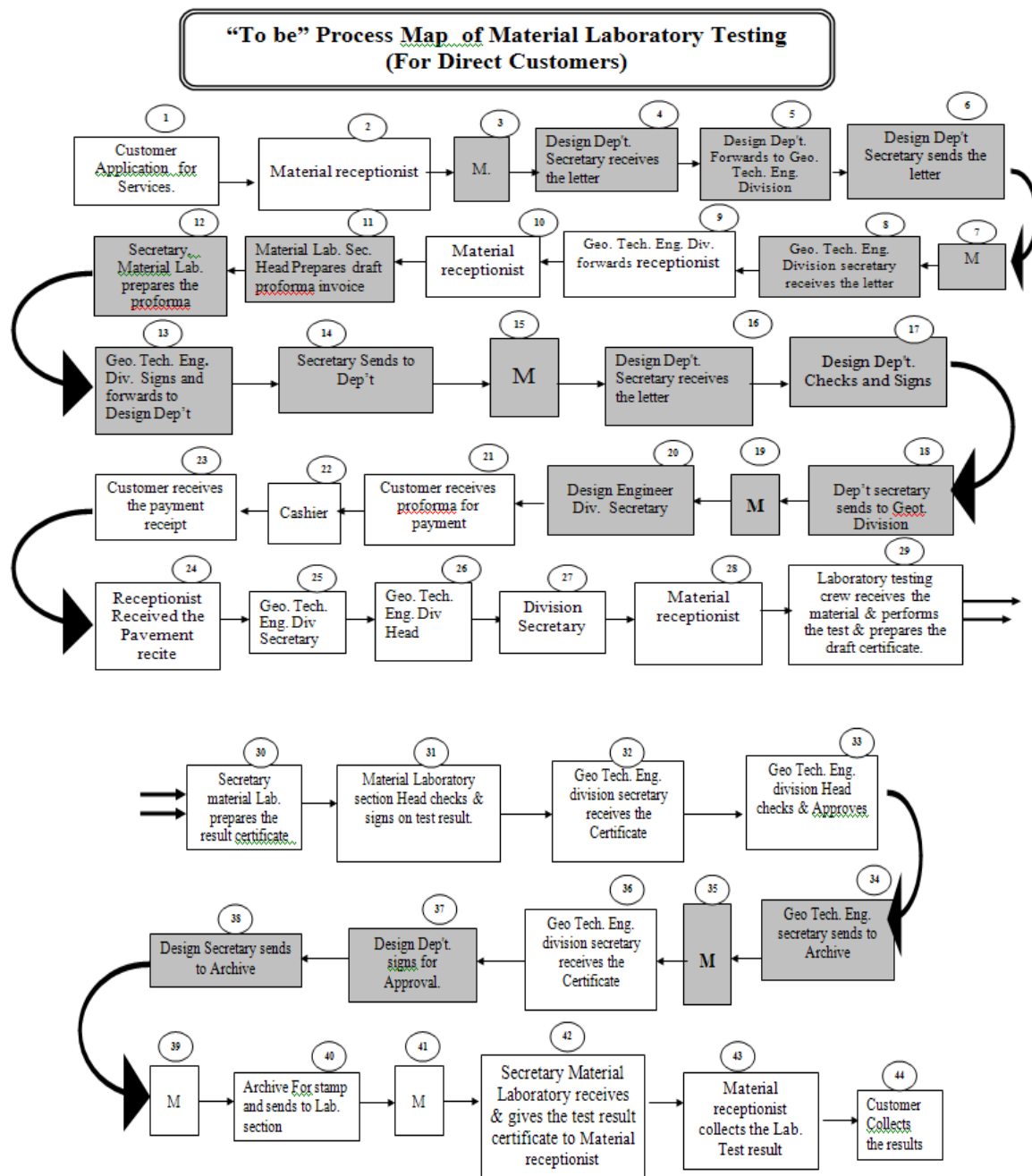


Chart1. Showing overall organization of TCDsco

1.5 Work flow in the company



Previous No. of Steps

44

13

Redesigned No. steps

24

Chart2.Process map of Laboratory testing section

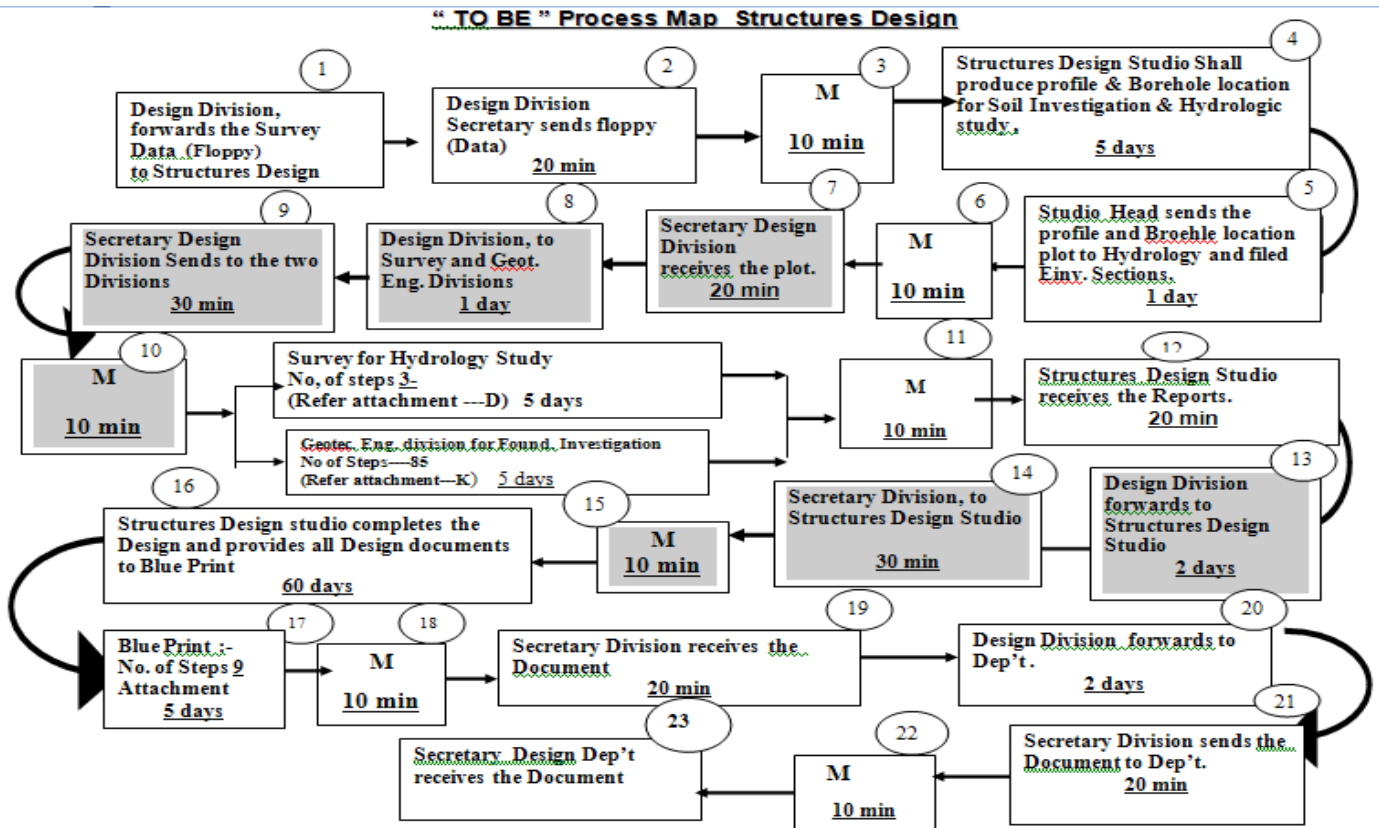


Chart3. process map of structures design

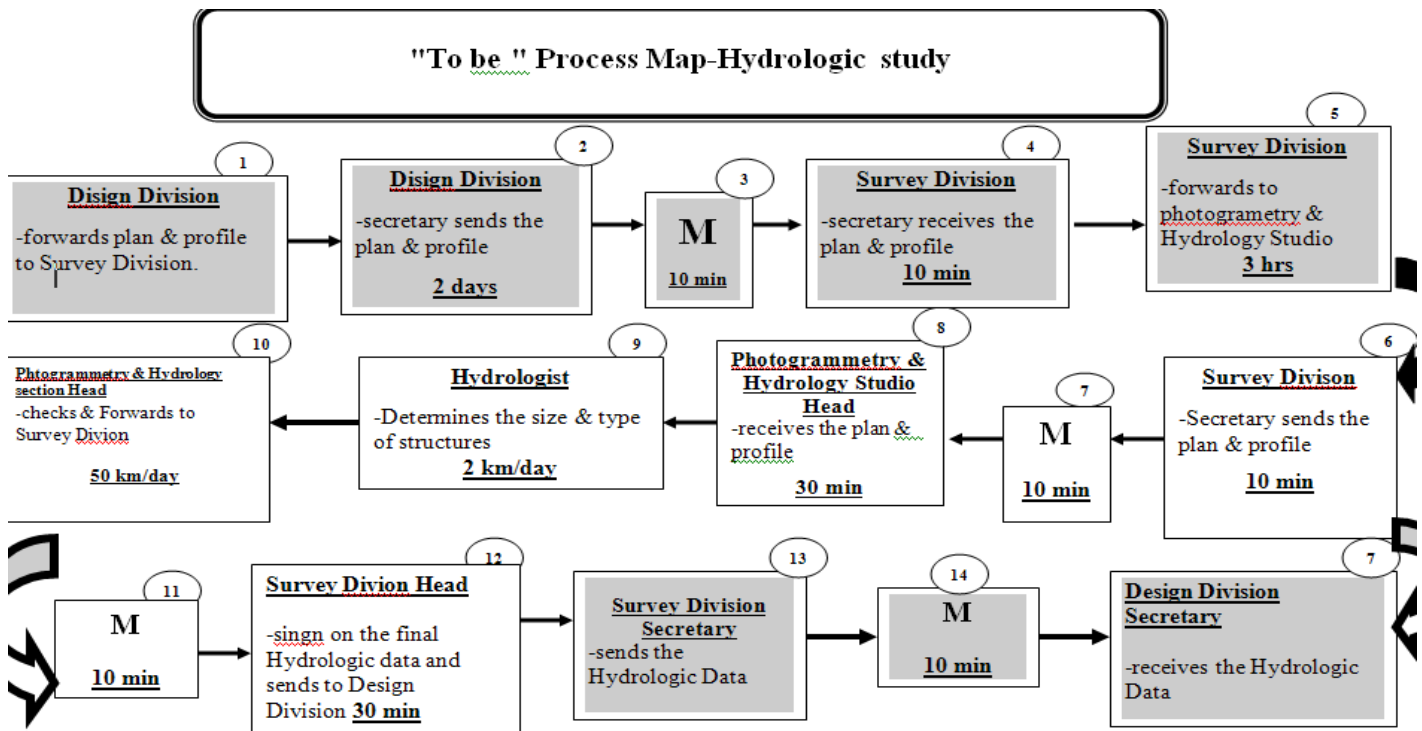


Chart4. Process map of hydrologic study



2. Overall internship experience

2.1. How became interned in TCDSCO.

The chance of being interned in TCDSCO is gained by appealing to the company early in May 2005(E.C). I took an application letter from UIIS office at the institute (AAIT). The application letter was submitted to TCDSCO geotechnical section manager Ato Mr X and they confirmed my hiring as intern.....Then on the month October 2013 I took the acceptance letter to the UIIS office for confirmation. The company accepts me for four month internship from October 13 up to February 113. And then I began my internship program as provided.

2.2. Sections of the company I was working

TCDSCO is a company which works transportation related designs and important laboratory tests. Also site investigation is the other known work of the company. And I have got the chance to work in design office and the laboratory sections of the company besides I was having a chance to visit site investigation which were done for G+4 mixed building around MEKANISA. TCDSCO has well organized three laboratory sections, This three sections I was working are Soil section, Asphalt section (which includes aggregate) and finally in the concrete testing laboratory. In each section I was working each and every test by myself with the help of formally working lab technicians and friends who are interns.

2.3. Work flow in the laboratory section

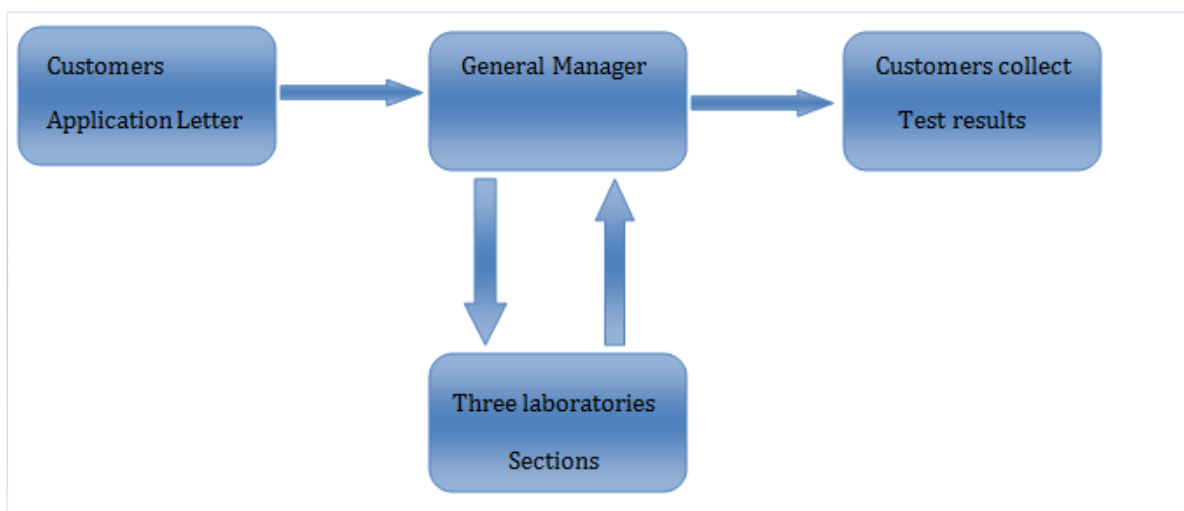


Chart5..Workflow the laboratory section



2.4. Work piece or work task I have been executing

In TCDS Co I was working in both design and laboratory sections of the company.

TCDS Co has three laboratory sections which are soil laboratory, concrete section and Asphalt laboratory. And I get full chance of working in these three laboratories. And this helps me to understand well different important engineering tests. While I was in TSDsco laboratory section I performed the following tests:

- Aggregate crushing value(ACV) test
- Aggregate impact value(AIV) test
- Ten percent fines value(TFV) test
- Loss Angeles Abrasion (LAA) test
- Sodium sulfate soundness (SSS) test
- Elongation and flakiness
- Bulk SSD Specific Gravity of coarse and fine aggregate
- Setting time of normal cement:
- Normal consistency of cement
- Silt content of sand
- Workability of mortar
- Compressive strength of mortar
- Sieve analysis for fine aggregate
- grading coarse aggregate
- Auto clave Expansion of cement
- Slump(Workability of concrete)test
- Compressive strength of concrete
- Compressive strength of blocks
- Concrete mix design(ACI Mix design method)
- Tension test for steel



- Ductility of Asphalt
- Flash point of Asphalt
- Penetration test for Asphalt
- Solubility of Asphalt
- **Specific gravity of Asphalt**
- Water content of Asphalt
- **Asphalt Mix Design**
- Grain Size Analysis-Hydrometer Test
- Atterberg Limits
- **Compaction Test (Procter Test)**
- **CBR and Swell**
- Linear shrinkage
- Specific gravity and absorption capacity of fine aggregate
- **Unconfined compressive strength (UCS) of soil**



➤ While I was in design studio my main task was developing the geometric design of high way road by using **civil designer** software specifically **Inroads Bentley**. my main tasks are listed below:

- ✓ Importing surveying data (i.e.Excel data sheet file).
- ✓ Digital Terrain Modeling(i.e. Triangulation, filtering and developing counter for corridor)
- ✓ Horizontal Alignment(i.e. Inserting, Editing and moving straights and curves of the alignment)
- ✓ X-section extraction and Editing.
- ✓ Plotting Ground profile
- ✓ Vertical Alignment (i.e. Inserting, Editing and moving straights and curves of the alignment)
- ✓ Defining road Templates and inserting (i.e. side slope, back slope and carriageway width).
- ✓ Developing Super elevation and Widening Design.
- ✓ First grading
- ✓ X-section area calculation (i.e. for each station)
- ✓ Volume of total Cut and Fill for each 1.5 Km in metric cube.
- ✓ Creating plan and profile drawings for every 1.5Km
- ✓ *Compiling plan, profile, super elevation, widening and edge elevations of carriageway on one Drawing paper for each 1.5 Km.*

2.5. Procedures used while I was performing my work

2.5.1 Procedures used in the design office of TCDSCO

In the design office of TCDSCO I was using specific standard design procedures which are used in the company. To assist this procedures three Geometric Design Manuals are used in the company, which are TCDSCO, Addis Ababa City Road Authority (AACRA), and Ethiopian Road Authority (ERA) Geometric Design Manuals. The company use this manuals according to the need of the client, but generally if the road is in Addis Ababa AACRA Manual is used for design, if the road to be designed is out of Addis Ababa ERA Manual is used, also if the client need the design in TCDSCO Manual the company use this manual for the design. Also the company used manual design of the road in earlier days, but now the company use Civil Designer Software. This



software make the design process simple compared to manual method and the geometric design of any highway is done by using this software, in the design room of TCDsco.



The major procedures used in the design room of TCDsco are listed and discussed below:

◆ Determining design standards of the road

The design standards to be used for roads of various traffic volumes (AADT) are summarized in the several following tables of ERA geometric design manual. Of these, Table 2-1 of chapter two presents an overview of design standards relating to road functional classification and traffic volumes, and illustrates the split between paved and unpaved standards.

Table 2-1: Design Standards vs. Road Classification and AADT

Road Functional Classification		Design Standard	Design Traffic Flow (AADT)*	Surface Type	Width (m)		Design Speed (km/hr)				Urban/Peri-Urban
					Carriageway	Shoulder	Flat	Rolling	Mountainous	Escarpment	
COLLECTORS FEEDER	MAIN TRUNK	DS1	10000–**15000	Paved	***Dual 2 x 7.3	See T.2-2	120	100	85	70	50
		DS2	5000–10000	Paved	7.3	See T.2-2	120	100	85	70	50
		DS3	1000–5000	Paved	7.0	See T.2-2	100	85	70	60	50
		DS4	200–1000	Paved	6.7	See T.2-2	85	70	60	50	50
		DS5	100–200	Unpaved	7.0	See T.2-2	70	60	50	40	50
		DS6	50–100	Unpaved	6.0	See T.2-2	60	50	40	30	50
		DS7	30–75	Unpaved	4.0	See T.2-2	60	50	40	30	50
		DS8	25–50	Unpaved	4.0	See T.2-2	60	50	40	30	50
		DS9	0–25	Unpaved	4.0	See T.2-2	60	40	30	20	40
		DS10	0–15	Unpaved	3.3	See T.2-2	60	40	30	20	40

* The design two-way traffic flow is recommended to be not more than one Design Standard step in excess of the first year AADT (excluding DS7). ** For traffic volume more than 15000 a different design approach should be followed. *** The width of each lane is 3.65m

Table1. Design standards vs. road classification and ADT



◆ **Developing Digital Terrain Model(DTM) (Triangulation)**

It is the process of making triangles by connecting the given spot Heights (SH) for a given distance let 50m throughout the whole rout. This means the software connect all points in the range of 50m by making triangles. Triangulation helps the computer to determine all intermediate elevations by interpolating. Finally it can draw the contours throughout the route. And this is the main input for ground cross-section extraction.

◆ **Horizontal Alignment**

Drawing horizontal alignment of the road means inserting straights and curves of the center line of the road along the selected rout without deflecting from the control points indicated by surveyor data as much as possible. we started this process by filter ring the center lines(CL) and intersection points(PI). For points which have no indicated PI point we inserted intersection points. Also for points with inaccessible PI we inserted POTA and POTB points. we insert and connect all inter section points and for each intersection point we insert appropriate horizontal curve radius by considering the minimum radius for the terrain type and design speed recommended by ERA manual tables for the DS road.

◆ **Cross-section extraction, Editing and Ground lines**

This is the process of extracting cross-sectional (transversal direction) profile of the natural ground for the right way of total 50m. We extract all ground x-sections for all stations also we edit and check all of them. After we extract all drawing the ground profile was the other step. This ground profile of the center line of road is important to draw vertical alignment of the road.

◆ **Vertical Alignment**

To develop vertical alignment of the road the first requirement was grading, which means reading the maximum and minimum grades specified by ERA manual in chapter two under tables from 2.3-2.12 for each Design standards(DS) of the road. For example, the minimum gradient is 0.5% and the maximum absolute gradient was 8% for DS3 road as provided in ERA manual in caper two of table 2.5 as shown below. When I developed the vertical alignment of the road I performed the following:-

- ✓ I insert appropriate grade , which means minimum gradient should be greater than or equal to 0.5%, which is the minimum requirement for longitudinal drainage and the maximum gradient should be less than or equal to the absolute maximum gradient specified by ERA manual.
- ✓ I insert vertical curves according to ERA manual recommendation of vertical curve length.
- ✓ I edit and move vertical alignment to full fill requirements like gradient, drainage and balance of cut and fill.

◆ Defining and inserting road Templates

Templates are drawings transverse direction cross-section of the road including its corridor, which includes side slope, back slope and carriageway width of the road. Standard rod way template and table used to determine back slope and side slope of road as provided by ERA geometric design manual in chapter six is shown bellow. In TCDSC design studio there are different types of templates for example Rural, Urban, rock soil and other types of Templates are available and according to the condition of the site we assigned these different Templates to different sections of the road.

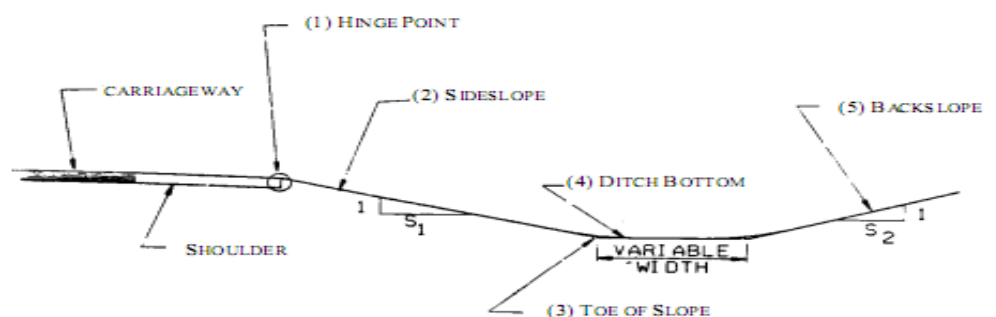


Figure 6-1: Designation of Roadside Regions

Source: AASHTO

Fig1. Designation of Road sides

Table 6-1: Slope Ratio Table – Vertical to Horizontal

Material	Height of Slope	Side Slope		Back Slope	Zone Description
		Cut	Fill		
Earth or Soil	0.0 - 1.0m	1:4	1:4	1:3	Recoverable
	1.0 - 2.0m	1:3	1:3	1:2	Non-recoverable
	Over 2.0m	1:2	1:2	1:1.5	Critical
Rock	Any height	See Standard Details			Critical
Black Cotton Soil*	0.0 - 2.0m	-	1:6	-	Recoverable
	Over 2.0m		1:4		

*Move ditch away from fill as shown in Figure 6-2

Table2. Slope relation table



◆ Super elevation and Widening Design

We determined super elevation and widening coordinates of the road by using Excel spread data sheet developed in ERA, this Excel sheet is linked and to give the outputs(i.e. super elevation and widening), it need inputs like BC,EC, Radius, e(%), intersection angle, curve direction(Lt&Rt) and length of Run-off(L). To determine the length of Run-off (L) we used table8.4 in chapter eight from ERA design manual, which is shown below. After inserting all necessary data the Excel sheet automatically provides coordinates of super elevation and widening and this coordinates are pates in Civil Designer Software.

	$V_r=30\text{ km/h}$	$V_r=40\text{ km/h}$	$V_r=50\text{ km/h}$	$V_r=60\text{ km/h}$	$V_r=70\text{ km/h}$	$V_r=85\text{ km/h}$	$V_r=100\text{ km/h}$	$V_r=120\text{ km/h}$
R	e	e	e	e	e	e	e	e
(m)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
7000	NC	0	NC	0	NC	0	NC	0
5000	NC	0	NC	0	NC	0	NC	0
3000	NC	0	NC	0	NC	0	RC	2.4
2500	NC	0	NC	0	NC	0	RC	2.9
2000	NC	0	NC	0	NC	0	RC	3.5
1500	NC	0	NC	0	NC	0	RC	4.6
1400	NC	0	NC	0	RC	2.1	RC	4.9
1300	NC	0	NC	0	RC	2.2	RC	5.2
1200	NC	0	NC	0	RC	2.4	RC	5.6
1000	NC	0	RC	2.2	RC	2.8	RC	6.5
900	NC	0	RC	2.4	RC	3.1	RC	7.1
800	NC	0	RC	2.7	RC	3.4	RC	7.6
700	NC	0	RC	2.8	RC	3.8	RC	8.0
600	NC	0	RC	3.4	RC	4.3	RC	8.0
500	NC	0	RC	3.9	RC	4.9	RC	8.0
400	RC	17	RC	4.7	RC	5.7	RC	8.0
300	2.1	17	RC	5.1	RC	6.7	RC	8.0
250	2.5	17	RC	5.8	RC	7.3	RC	8.0
200	3.0	17	RC	6.2	RC	7.9	RC	8.0
175	3.4	17	RC	6.7	RC	8.0	RC	8.0
150	3.8	18	RC	7.0	RC	8.0	RC	8.0
140	4.0	19	RC	7.4	RC	8.0	RC	8.0
130	4.2	20	RC	7.8	RC	8.0	RC	8.0
120	4.4	21	RC	8.0	RC	8.0	RC	8.0
110	4.7	23	RC	8.0	RC	8.0	RC	8.0
100	4.9	23	RC	8.0	RC	8.0	RC	8.0
90	5.2	25	RC	8.0	RC	8.0	RC	8.0
80	5.5	26	RC	8.0	RC	8.0	RC	8.0
70	5.9	28	RC	8.0	RC	8.0	RC	8.0
60	6.4	31	RC	8.0	RC	8.0	RC	8.0
50	6.9	33	RC	8.0	RC	8.0	RC	8.0
40	7.5	36	RC	8.0	RC	8.0	RC	8.0
30	8.0	38	RC	8.0	RC	8.0	RC	8.0

$R_{\min}=30$

$R_{\min}=50$

$R_{\min}=80$

$R_{\min}=125$

$R_{\min}=175$

$R_{\min}=270$

$R_{\min}=395$

$R_{\min}=665$

$e_{\max}$ = 8.0%

R = radius of curve

V = assumed design speed

e = rate of superlevation

L = minimum length of runoff (does not include tangent runoff)

NC = normal crown section

RC = remove adverse crown, superlevation at normal crown slope

Note : Lengths rounded in multiples of 10m to permit simpler calculations

Table 3 Superlevation Rates and Length of Run-Off: 8%



✓ **Determining cross-section area for each station and Volume of total Cut and Fill for each 1.5 Km in metric cube.**

After all the above procedures are completed well, which means for each and every station design cross section and ground cross sections are fully developed and combined by the given Templates. Then area calculation is continued. we calculated the area between the design cross section and the ground cross sections. After all areas are calculated total volumes of cut and fill are computed for each 1.5km section of the road throughout the route. The area and volumes are calculated by using civil Designer software.

✓ ***Creating plan and profile drawings for every 1.5Km***

The plane drawing contains contour, centerline horizontal alignment, cut and fill edges, BM, GPS, and all other necessary data's. Also the profile, widening and super elevation drawings are created. And it contains vertical curve alignment and template edge elevation data's. This two drawing papers are saved as Auto CAD file name and they can be opened in Auto CAD software.

✓ **Compiling plan, profile, super elevation, widening and edge elevations of carriageway on one Drawing paper for each 1.5 Km.**

Finally we create Compiled plan, profile, super elevation, and widening and edge elevations of carriageway on one Drawing paper for each 1.5 Km by using Auto CAD software. And this will conclude all our design office room work task procedures.



2.5.2 Procedures used in the laboratory section of TCDsco.

In the laboratory section of TCDsco different sub sections are available which are Aggregate and asphalt testing laboratory, concrete testing laboratory and Geotechnical laboratory.

2.5.2.1 Procedures used In the Aggregate and Asphalt Testing Laboratory

❖ Aggregate impact value(AIV) test(BS B12 Part 111)

Objective: To assess the resistance of an aggregate to mechanical sudden impact load by the Aggregate impact value test.

Test Procedure

1. The material used is aggregate passing a 12.70 mm sieve and retained on a 9.52 mm sieve. It shall be clean and dry (washed if necessary) but it must not be dried for longer than 4 hours nor at a temperature higher than 110°C may otherwise certain aggregates be damaged.
2. The whole of the test sample (mass A) is placed in the steel mold and compacted by a single tamping of 25 strokes of the tamping rod.
3. The test sample is subjected to 15 blows of the hammer dropping 381 mm, each being delivered at an interval not less than one second.
4. The crushed aggregate is sieved over a 2.36 mm sieve. The fraction passing 2.36 mm is weighed to the nearest 0.1 g (mass B). The fraction retained on the sieve is also weighed (mass C). If $\{A-(B+C)\} > 1$ gram, the result shall be discarded and a fresh test made.

Calculation and Result

The aggregate impact value (AIV) is: $AIV = (B/A) \times 100 (\%) \dots (1)$

An average is taken of the two tests and the result is recorded to the nearest whole number as the Aggregate Impact Value. The AIV is normally about 105 per cent of the Aggregate Crushing Value and it can be used for the same purpose. For weak aggregates, the required load for the first ten per cent fines test can be estimated by means of the formula:

Required load (KN) = $4000/AIV \dots (2)$

Example .Aggregate Impact Value (AIV) Test in dry condition

	A	B
Retain on No8®	319	316
Pass in No8®	27	29
Total	346	345
AIV((p/T)*100)	7.8%	8.41%

$$\text{Average AIV} = \frac{7.8+8.41}{2} = 8.11 \approx 8\% \quad \text{Test result: AIV} = 8\%$$

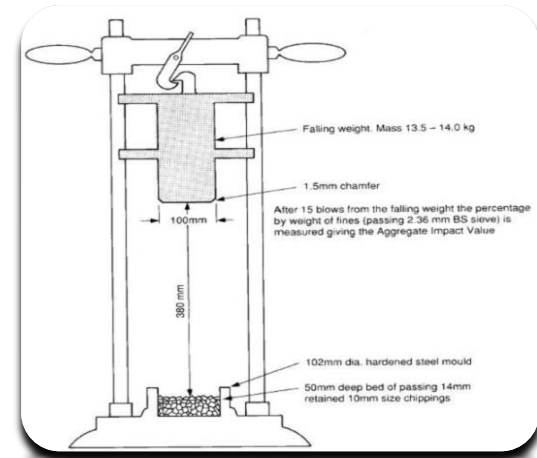


Fig: 2. AIV machine

❖ Ten Percent Fines Value(TFV) test (BS B12 Part 111)

Objective: To assess the load required to crush only ten percent of the material in ten minutes gradually by the Ten percent Fines value test.

Test Procedure

1. The material used for both tests is aggregate passing a 12.70 mm sieve and retained on a 9.52 mm sieve. It shall be clean and dry (washed if necessary) but it must not be dried for longer than 4 hours nor at a temperature higher than 110°C may otherwise certain aggregates be damaged.
2. The required volume is obtained by filling the measuring cylinder in three layers, each tamped 25 times with the rod and the top struck level. This volume is then weighed to the nearest 0.1g (mass A).
3. The material from the measuring cylinder is placed in the test cylinder in three layers, each tamped 25 times with the rod. The depth of the sample will then be about 100 mm. The plunger is lowered onto the sample and rotated gently to seat it and level it.
4. The cylinder, plunger and sample are placed in the compression testing machine. Force is applied at a uniform rate for 10 minutes.
5. The sample is then sieved over a 2.36 mm sieve. The material passing 2.36 mm is then weighed (mass B) and expressed as a percentage of the original mass [y=100% B/A].

Calculation and Result

6. If the percentage fines lies between 7.5% and 12.5%, the following calculation for Ten Percent Fines Value (TFV) is made:

$$\text{TFV} = \text{Force to produce 10\% fines} = 14x y + 4 \quad \dots (2) \quad \text{where } x = \text{maximum force used (KN)}$$

y = percentage fines from the test (%)

The result should be reported to the nearest whole number.

- If the percentage fines lie outside the range 7.5 to 12.5, the test must be repeated, applying the force given by the formula over a period of 10 minutes. Two tests are required and the ten percent fines values (TFV) are averaged to obtain the final result, reported to the nearest 10 kN (for forces > 100kN)

Example Ten percent finesse value wet condition applied load=270kN

	A
Retain on No8@	2502
Pass in No8@	222
Total	2724
TFV((p/T)*100)	8.15≈8%

Finally by using Linear Graph method

Exact TFV is at 280kN

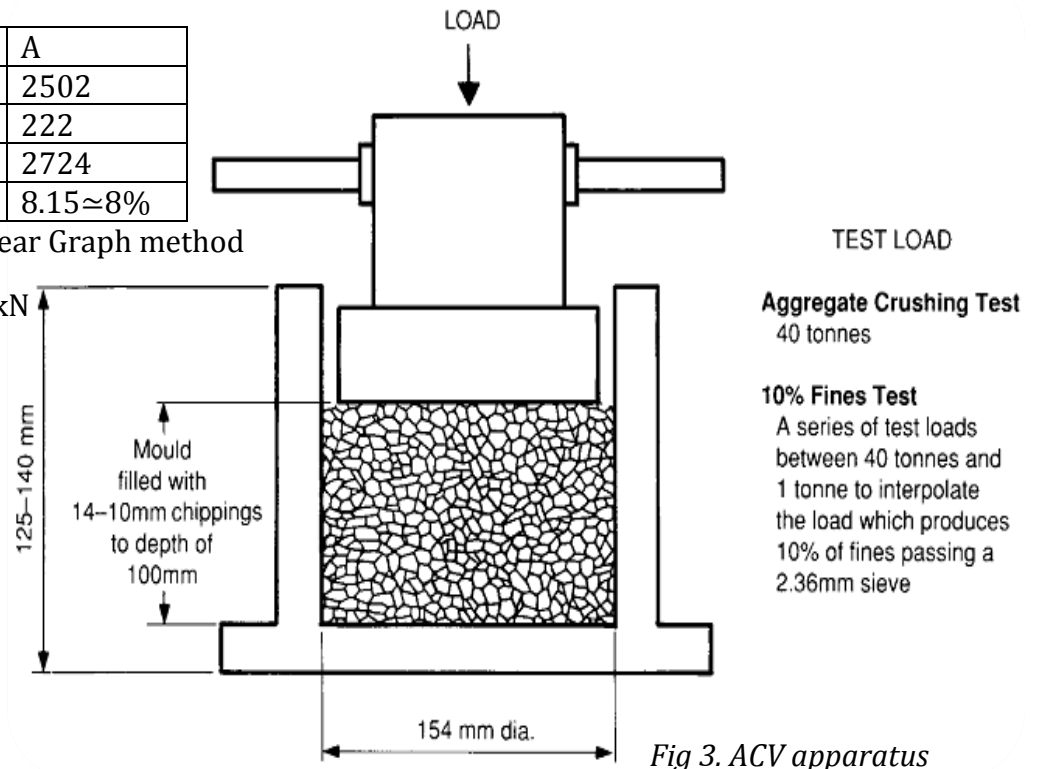


Fig 3. ACV apparatus

❖ Aggregate Crushing Value (BS B12 Part 110)

Objective: To assess the resistance of an aggregate to mechanical gradual applied load by the Aggregate crushing value test.

Test Procedure

- The apparatus and sample preparation is identical with that described above for the Ten Percent Fines Test.
- The cylinder, plunger and sample are placed in the compression test machine. It is loaded at a uniform rate so that a force of 400 KN is reached in 10minutes. The load is then released.
- The percentage fines is then determined as before. The material passing 2.36 mm is weighed (mass B) and expressed as a percentage of the original mass (mass A) to give the aggregate crushing value (ACV). $ACV = \frac{B}{A} \times 100\% \dots (4)$

Calculation and Results



The average is taken of two tests and the result recorded as Aggregate Crushing Value. If the percentage fines exceed 30, the result may be anomalous as the broken pieces of aggregate will tend to fill the voids and prevent further crushing. In this case, the Ten

Percent Fines Test is more appropriate

Example Aggregate Crushing Value (ACV) Test (BS B12 Part 110)

	A	B
Retain on No8®	1781	1945
Pass in No8®	656	567
Total	2437	2512
ACV $((p/T)*100)$	26.9 %	22.6%

Average ACV = $\frac{27+23}{2} = 25\%$ Test result: ACV = 25%

❖ Loss Angeles Abrasion (LAA)(ASHTO T-96)



Fig: 4.ACV mold and sample

Objective

To determine the resistance of coarse aggregate to impact in a rotating cylinder containing metallic spheres.

Test Procedure

1. Place the test specimen and abrasive charge in the Los Angeles Abrasive Testing Machine and close the opening with the dust-tight cover.
2. Start the testing machine and allow operating for the required number of revolutions.
3. When the testing machine has completed rotating the required number of revolutions, remove the cover and carefully empty the entire contents into a pan. Remove the abrasive charge from the pan.
4. Separate the test specimen on the 4.75-mm sieve, then sieve the passing 4.75-mm material on the 1.70-mm sieve. Combine the material retained on the 4.75 and 1.70-mm sieves. Weigh and record these values to the nearest 1 g.
5. If the mass of material retained on the 1.70-mm sieve was determined after 100 revolutions, return the entire test specimen, including the material passing the 1.70-mm sieve, to the testing machine. Close the opening in the testing machine and rate for the required number of additional revolutions, then repeat Step 3 and 4 above

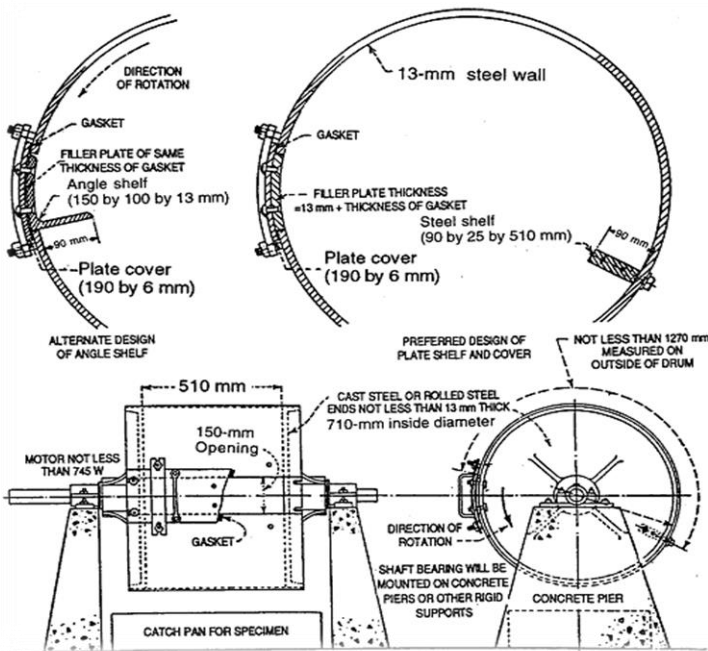


Fig: 5. LAA machine

Calculation and Reporting

9. Calculate the “Percent Wear” to the nearest % using the following equation:

$$\text{Percent Wear} = [(A - B)/A] \times 100$$

Where: A = Mass of original test specimen, to the nearest 1 g

B = Mass retained on the 1.70-mm sieve after revolutions

Example Loss Angeles Abrasion Test Grading “B” 48+000 LHS 150m depth average 0.6m pit 2

$$LAA = \frac{5000 - 4077}{5000} \times 100 = 18.46\% \approx 18\%$$

➤ Sodium sulfate soundness (SSS)(ASHTO T-104) test

Objective: This test method measures aggregate resistance to disintegration.

Test Procedure

1. Immerse samples in the prepared solution of sodium or magnesium sulfate for 16 to 18 hours.
2. Cover the tank to reduce evaporation and prevent contamination.



3. Maintain the solution at a temperature of 20 to 24°C (68 to 75°F) for the immersion period.
4. Remove the aggregate samples from the solution, permit them to drain for 15 ± 5 minutes, and place in the drying oven.

Table 4 . Sample Size Fractions for Sodium sulfate soundness (SSS) test

Item	Sieve Passing	Sieve Retained	Weight, g
Base Material	4.75 mm (No. 4)	2.36 mm (No. 8)	100 ± 5
Base Material	2.36 mm (No. 8)	1.18 mm (No. 16)	100 ± 5
Base Material	1.18 mm (No. 16)	600 μ m (No. 30)	100 ± 5
Base Material	600 μ m (No. 30)	300 μ m (No. 50)	100 ± 5
Course aggregate	2'	1 1/2''	2000
Course aggregate	1 1/2''	3/4''	1500
Course aggregate	3/4''	3/8''	1000
Course aggregate		retained on No 4	300

**Fig: 6.seive shaker**

5. Oven-dry the samples until they reach a constant mass. Constant mass will be considered achieved when the mass loss is less than 0.1% of the sample mass in four hours of drying.
6. Allow the samples to cool to room temperature.
7. Repeat Sections 1 through 6 for a total of five cycles unless otherwise specified.
8. After completion of the final cycle, allow the sample to cool to room temperature.
9. Wash sodium sulfate and magnesium sulfate free from the sample. Wash by circulating water continuously at $43 \pm 6^\circ\text{C}$ ($110 \pm 10^\circ\text{F}$) through the samples in their containers. Determine the thoroughness of washing by obtaining a sample of water flushed through the aggregate; check by adding 0.2 M barium chloride to the rinse water. If the water becomes cloudy, additional washing is required.
10. Oven-dry each fraction to a constant mass.
11. Sieve to refusal in accordance with the following sieve sizes.

Calculations



1. Calculate Individual Percent Loss of each size fraction (c_i):

$$c_i = [(a_i - b_i) / a_i] 100 \quad d_i = (c_i) \bullet \text{Normalized Gradation Percent}$$

Where: a_i = initial mass of each size fraction b_i = final mass of each size fraction.

2. Calculate Normalized Percent Loss of each size fraction (d_i)
3. Calculate Total Percent Loss

Example Test No1 Soundness Test for fine Aggregates (13.5-6mm)

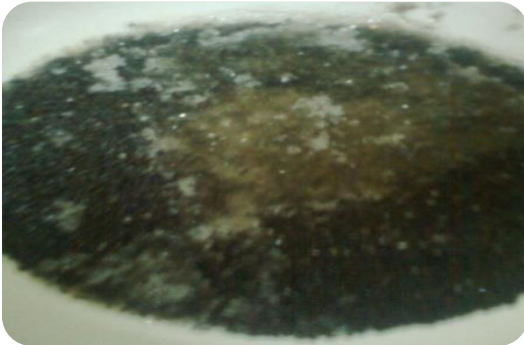


Fig: 7. Sulphate attacked aggregate under test.

Table 5 .Gradation for soundness

Sieve size	Weight	%Retain	% Pass
3/8'	-	-	100
No 4	0.65	0.13	
" 8	238.48	47.7	
" 16	103.86	20.77	
" 30	49.89	9.98	
" 50	29.39	5.88	
" 100	17.65	3.53	
pass	60.08	12.01	
	500.00	100.00	

Soundness calculation table

Sieve size	Weight before test(gm)	Weight after test(gm)	Loss	% Loss	Average Loss
No 8	100	94.14	5.86	5.86	2.8
" 16	100	92.51	7.49	7.49	1.56
" 30	100	91.75	8.25	8.25	0.82
" 50	100	91.99	8.01	8.01	0.47
					$\Sigma=5.65$

Result report: Soundness Loss by sodium sulfate = 6%

✓ Bulk SSD Specific Gravity and water Absorption for coarse aggregate(AASHTO T- 85)

Objective: Determining the bulk specific gravity of coarse aggregate in a saturated surface-dry (SSD) condition.



Test Procedure

1. Make all weightings to the nearest gram.
2. Weigh the empty pail and record as tare mass of pail, (M1).
3. Submerge the pail, as shown in Figure 1, and exercise care when immersing to see that no air is trapped under the pail. Adjust the water level in the container to intersect the straight portion of the lower section of the hook-ended rod. Place a reference mark at this intersection of the rod with the water surface or insert an overflow spout through the side of the water container at this level. Adjust to this same water level within ± 25 mm for all future "in water" weighings. Weigh the pail and rod in water and record as mass, M2. Remove the pail from the water container and invert it to dry, as it will be used later as a container for the sample when weighed in air.
4. Roll the wet sample in a large absorbent cloth until all excess water is removed, although the surfaces of the particles still appear to be damp. The larger fragments or particles may be individually wiped. Exercise care to avoid evaporation of absorbed water during the operation of surface drying.
5. Immediately after it has reached a saturated surface-dry (SSD) condition place the sample in the dry pail and weigh in air. Record this mass, M3.
6. Remove the pail and sample from the balance and add enough water to the pail to completely inundate the sample. Stir the inundated sample with the spoon, rod or hand in order to remove any entrapped air.
7. Add enough water to almost fill the pail and attach the pail to the balance by means of the hook-ended rod. Lower and immerse the pail and sample to within ± 25 mm of the same level where the pail was when filled with water only. Exercise care when immersing to see that no air is trapped under the pail. Weigh the pail, rod and sample in water and record as mass, M4.
8. oven dry the sample and measure the mass.

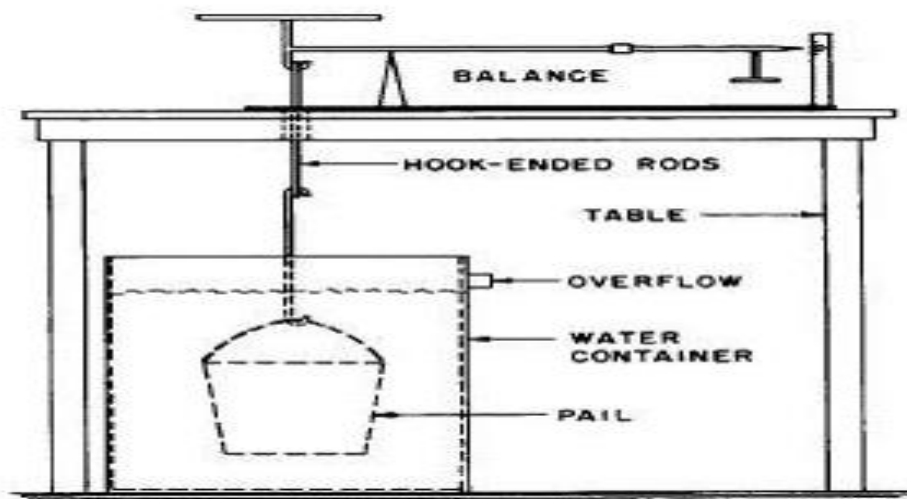


Fig: 8. specific gravity of course aggregate test model diagram

Calculations

1. The mass of the sample in water, M_w , is equal to the mass of the pail, rod and sample in water minus the mass of the pail and rod in water $M_w = M_4 - M_2$.



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2. The mass of the sample in saturated SSD condition in air, M_a , is equal to the mass of the SSD sample and dry pail in air minus the mass is the dry empty pail: $M_a = M_3 - M_1$
3. Calculate the bulk specific gravity (SSD) from the following formula:
Bulk Sp. Gr. (SSD) = $M_a / (M_a - M_w)$
4. Duplicate determinations should check to within ± 0.02 .

Example:

Table6. Bulk Specific gravity (SSD & dry basis) for aggregate size (13.2-6mm) (ASHTO-T85)

	Sample (a)	Sample (b)
A= Mass of oven dry	213.60	2131.24
B= Mass of saturated surface dry(SSD) in air	2177.28	2174.31
C= Mass of saturated test sample in water	1405.80	1400.00
Bulk Specific gravity SSD basis= $B/(B-C)$	$2.822 \approx 2.82$	$2.809 \approx 2.81$
Average Bulk Specific gravity SSD basis	2.82	
Bulk Specific gravity Dry basis= $A/(B-C)$	$2.766 \approx 2.77$	$2.752 \approx 2.76$
Average Bulk Specific gravity Dry basis	2.77	
Water Absorption	2.05	2.02
Average Water Absorption	2.0	



Fig: 9. Specific gravity balance

✓ **Elongation index(BS 812-100)**

Objective: To determine the percentage by mass of elongated particles to the total mass of sample.

Sample Preparation

Use the material retained on any of the following sieves: $\frac{3}{4}$ ", $\frac{1}{2}$ ", $\frac{3}{8}$ ", $\frac{1}{4}$ " or the #4 sieve and has been placed into separate containers. Aggregates retained on each sieve which comprises at least 4 percent of the total sample, shall be tested.

Test Procedure

1. Wash and oven dry samples to a constant weight at 110 ± 5 °C. (230 ± 9 °F.)
2. Test each of the particles in each size fraction using the elongation gauge for each sieve size.
3. Separate the particles passing through the elongation gauge from those that do not pass through.
4. Weigh the particles passing the elongation gauge to the nearest 0.1 gram.



5. Weigh the particles retained on the gauge to the nearest 0.1 gram.

Calculation

$$\% \text{ Elongation Index} = \frac{A + A1 + A2}{A + A1 + A2 + B + B1 + B2} \times 100$$

Where,

A, A1, A2 = Weight passing a given elongation gauge

B, B1, B2 = Weight retained on the same elongation gauge



Fig: 10.Elongation gauge

✓ *Flakiness index (BS 812-10)*

Objective: The Flakiness Index test determines the percentage of flat particles in a seal coat aggregate.

Test Procedure

1. Wash and oven dry samples to a constant weight at $110 \pm 5^\circ\text{C}$. ($230 \pm 9^\circ\text{F}$)
2. Test each of the particles in each size fraction using the slot for each sieve size.
3. Separate the particles passing through the slot from those that do not pass through.
4. Weigh the particles passing the slot to the nearest 0.1 gram.
5. Weigh the particles retained on the gauge to the nearest 0.1 gram.

Calculation

$$\% \text{ Flakiness Index} = \frac{A + A1 + A2}{A + A1 + A2 + B + B1 + B2} \times 100$$

Where:

A, A1, A2 = Weight passing a given slot

B, B1, B2 = Weight retained on the same slot



Fig: 11.Flakiness slot

✓ *Ductility of Asphalt*

Objective: To measure of the tensile properties of the polymer modified asphalt cement residue of a polymer modified emulsified asphalt.

Test Procedure

1. The sample shall consist of the asphalt cement residue obtained from the distillation of a polymer modified emulsified asphalt. Strain the melted sample through a 300 mm sieve
2. After a thorough stirring pour the sample in the mold. Take care not to disarrange the parts and thus distort the specimen.

3. Allow the test specimen to cool to room temperature for 15 minutes and then place in a water bath at 40 °C for 15 minutes.

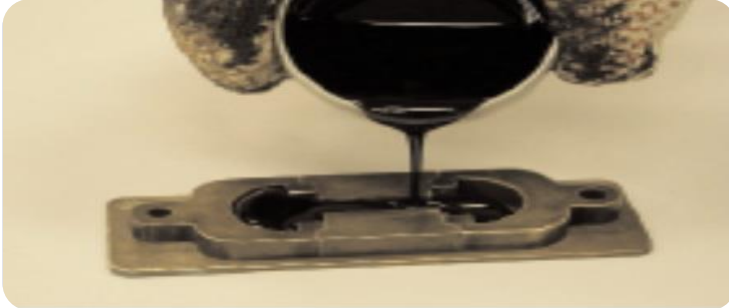


Fig : 12. Ductility of Asphalt Mold and testing machine while in test

4. Remove the test specimen from the water bath and cut off excess bitumen with a hot, straight edged putty knife or spatula to make the mold just level full
5. Place the trimmed specimen and mold back in the water bath at 40 °C for 30 minutes prior to testing.
6. Remove the test specimen from the plate by a shearing action between the specimen and plate, avoiding any bending of the test specimen. Detach the side pieces and attach the specimen to the pins.
7. Position the cross leads and ensures that the load cells are attached to the specimen.
8. Set the elongation rate for 5 cm/min.
9. Elongate the specimen for 100 cm or until the test specimen ruptures.

✓ Flash and Fire point of Asphalt (ASTM D 92)

Objective: To determine the Flash and Fire points of petroleum products

Test Procedure

1. Place the apparatus on level, solid, vibration free table and where no drafts are present. If there are drafts, it will be necessary to shield the apparatus
2. Place the thermometer in a proper position with respect to the cup
3. Fill the sample cup to the filling line
4. N.B. the temperature of the material should be as low as possible, and
5. Maximum 56 °C below the expected flash point
6. Light the test flame and adjust its position and diameter
7. Apply heat and adjust the rate of temperature rise as the test proceeds
8. Starting at minimum 28 °C below the flash point, apply one sweep of the test flame for every 2 °C rise on the thermometer
9. N.B. the flame for the test flame to cross the test cup should be approximately 1 second
10. The flash point is recorded as the reading on the thermometer when the 1st true flash appears on the sample surface



fig13. flash and firepoint



11. To determine the fire point, continue heating at specified rate of 5-6 °C and apply the test flame for each 2 °C rise in temperature. The fire point is recorded as the thermometer reading when the sample ignites and continues to burn for at least 5 seconds

Calculations

Correction applied for change in atmospheric pressure

Corrected value = $C + 0.03 (760 - P)$

Where, C – observed flash/fire point temperature to the nearest 2 °C

P – Barometric pressure in mmHg

✓ Solubility (ASTM D 2042)

Objective: To determine the degree of solubility of asphalt cement in trichloro-ethylene

Test Procedure

1. Place the gooch crucible plus one thickness of the glass fiber pad in an oven at 110 ± 5 °C for 15 minutes, allow to cool in a desiccators and weigh
2. Take 2 cm of asphalt and 100 cc of tri chloro-ethylene to the beaker
3. Continuously agitate the beaker until all the asphalt cement is uniformly dispersed in the solution
4. Cover the container and set aside for at least 15 minutes
5. Filter the solution in the filter in the filtering gooch crucible
6. Remove the gooch crucible from the filtering tube, carefully clean off any bitumen from the bottom of the crucible with trichloro-ethylene
7. Dry and weigh the material retained in the filter

Calculation % soluble = $100 - \frac{A}{B} * 100$ Where, A – weight of insoluble material

% in soluble = $\frac{A}{B} * 100$ B – weight of asphalt cement sample

NOTE: For percentage of insoluble in asphalt concrete sample less than 1 %, report to the nearest 0.01 %. For percentage of insoluble greater than 1.0 %, report to the nearest 0.1 %

✓ Specific Gravity (ASTM D 70)

✓ **Objective:** To determine the specific gravity of Asphalt

Test Procedure

1. Fill the beaker partially with distilled water and place it in the water bath
2. Take the weight of Pycnometer (clean and dry)

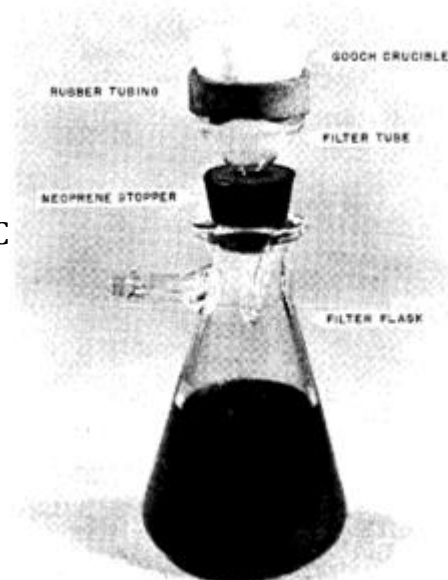


Figure 12 Filtering Apparatus Assembly



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3. Fill the Pycnometer with distilled water and place in the beaker at $25 \pm 0.1^\circ \text{C}$ for at least 30 minutes. N.B. the water level should be above the Pycnometer
4. Pick the Pycnometer from the beaker, dry the surface and weigh
5. Melt the bituminous sample until it is sufficiently fluid to pour; stir gently to prevent local overheating
6. A clean, dry and preheated Pycnometer is filled with the material to approximately $\frac{3}{4}$ of its capacity. Cool the Pycnometer to room temperature for 40 minutes and weigh the Pycnometer
7. Fill the Pycnometer with distilled water and place in the beaker standing in the water bath for a minimum of 30 minutes
8. Pick up the Pycnometer from the beaker, dry the surface and weigh

Calculation Specific Gravity = $\frac{C-A}{(B-A)-(D-C)}$

Where, A – Mass of Pycnometer C – Mass of Pycnometer partially filled with sample
 B – Mass of Pycnometer filled with distilled water D – Mass of Pycnometer + Sample + Water



Fig14.pycnometer filled with asphalt

ASPHALT MIX DESIGN PROCEDURE

The steps involved in the mix design procedure are

(a) select an aggregate grading fitting the grading band of the MoSRT&H specifications (b) cast a set of Marshall test specimens of asphalt mixes with aggregates graded to the selected grading and with varying asphalt contents (c) test the specimens for the Marshall properties and (d) choose the asphalt content offering the optimum Marshall properties in accordance with the criteria suggested in MS-2, as the design asphalt content.

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air voids (V_a), per cent voids in mineral aggregate (VMA), per cent voids filled with bitumen (VFB), unit weight, stability and flow. Shown in Fig. 2 to 7. Marshall Design criteria as adopted by the MoSRT&H Specifications are given in Table 1.

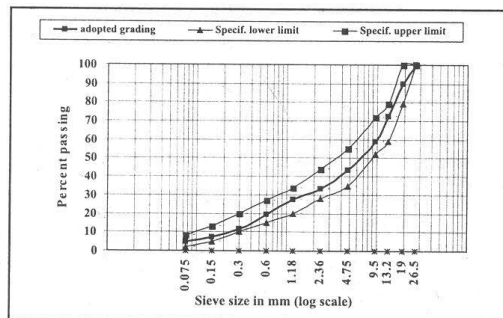


Fig. 1. Aggregate Grading in the Design Example

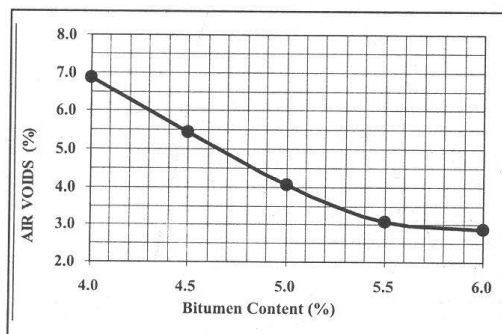


Fig. 2

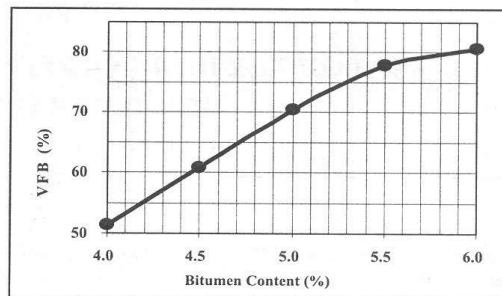


Fig. 4

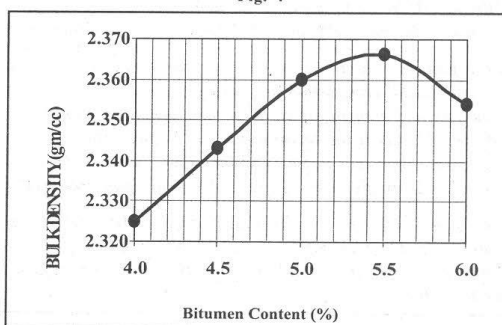
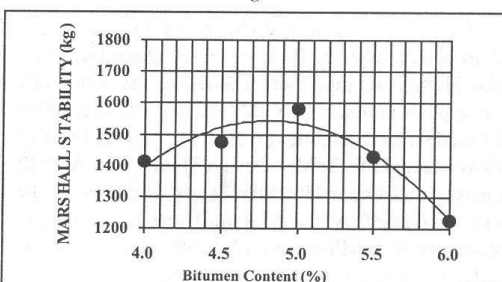


Fig. 5



Therefore according to the design table as per provided the quantity of each aggregate (fine or coarse) is being determined from an iteration. And this value is just reported to the clients.offcourse tentative check for use of what is being reported will be checked by the owner such as ERA accordingly.

✓ Penetration test for Asphalt(ASTM D 5)

Test procedure

1. Material identification.
2. Date Air Temperature oC
3. Date of preparation of test Specimens
4. Depth of sample in container (specified to be at least 10 mm. greater than depth of penetration of needle) mm
5. Length of air cooling period before placing in controlled waterbath (specified to be between 1 1/2 and 2 hr.)
6. Clock time specimen placed in controlled water bath .
7. Clock time specimen removed from controlled water bath .
8. Interval in controlled water bath (specified to be b/n 1 1/2 and 2 hr.)
9. Weight of load on needle gm
10. Time of application of needle to specimen sec.
11. Temperature of controlled water bath oC
12. Take readings until 3 penetration values are secured whose average meets the tolerance requirements. Circle the 3 penetration values used in computing the penetration value recorded on line 13. Report penetration value as the nearest whole number.
13. Penetration value for mate

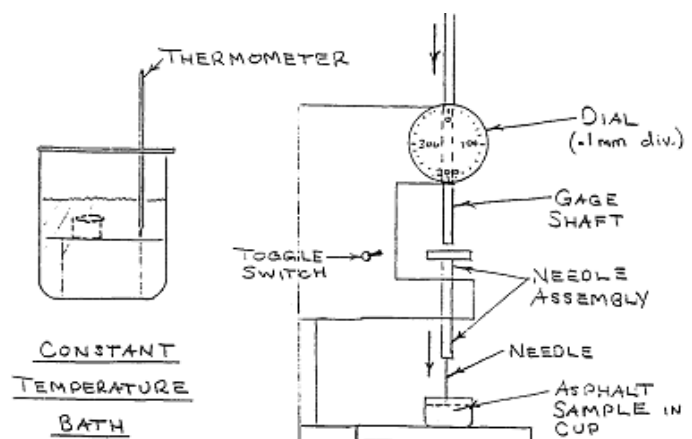


Fig15. Penetration container and penetrometer

Calculation



Trial	1	2	3	4	5	6	7	8
Final								
Initial								
penetration								

2.5.2.2 Procedures used In Geotechnical (soil) Testing Laboratory

✓ Moisture content

Objective To determine the amount of water present in a soil i.e. moisture content

Test procedures

1. Clean and dry the container, then weigh it to the nearest 0.1g
2. A representative sample shall be crumbled and loosely placed in the container
 - For fine grained soils the sample weight shall be min
 - For medium grained soils the sample weight shall be min 300g
 - For coarse grained soils the sample weight shall be min 3kg
1. The container with sample shall immediately be weighed
2. After drying, weigh the container and the contents.

Calculations

Calculate the moisture content of the soil specimen, w , as a percentage of the dry soil mass to the nearest .1% from the equation:

$$W = \left(\frac{m_2 - m_1}{m_3 - m_1} \right) \times 100(\%)$$

Where, M_1 is the mass of the container, M_2 is the mass of the container and wet soil M_3 is the mass of the container and dry soil

✓ Grain Size Analysis-Hydrometer Test

Objective: To plot continuous particle size distribution curve of a solution Hydrometer method covers the determination of particle size distribution in a soil from the coarser sand size to the clay size by sedimentation. The mesh of the finest screen commercially available is 75 μm . If at least 10% of the particles in the soil under test are smaller than 75 μm (No. 200) sieve, sedimentation has to be carried out.

Test Procedure

1. In hydrometer test, the grain size is determined on the basis of the settling rate of the particles in a liquid. The relationship between diameter of grains and speed of settling of a sphere is direct.
2. About 20 to 50 gm of the soil to be tested is taken in natural wet condition (m_w), more if the soil particle are coarse, and less if they are finer. The sample is then



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soaked in 100-200 cm³ of distilled water in a glass bowl, with the harder lumps being broken up by moderate hand pressure, and the solution is left to rest.

3. After soaking for at least one whole night the solution is agitated again and eventually diluted by the addition of little water.
4. The diluted solution is poured into mechanical operating stirring device in order to crush the soil lumps in to fines.
5. The solution is poured in the settling cylinder with dispersing agent to prevent coagulation, and then the cylinder is filled with distilled water, up to the 1000 cm³ mark.
6. The cylinders should be kept where no open windows, direct sunshine, over heat, or vibration effect might act upon them.
7. Great care should be taken to make the temperature of water identical to the suspension.



Fig16. Hydrometer cylinder under test

8. Now onwards, the density (specific gravity) of the suspended solution is subsequently measured at the different times after having started the test.
9. Finally we will use formulas to convert time for settling and hydrometer reading into diameter of soil grains.

✓ **Atterberg Limits**

Objective: To determine the plasticity index (PI)

✓ **Test procedure**

• **Liquid limit (LL)**

1. The tests are conducted on soil samples passing 0.425mm (No. 40) sieve.
2. Place the soil sample on a mixing dish and thoroughly mix it with distilled water.
3. Place the mixed sample on casagrande cup by squeezing to prevent air entrapment.
4. The soil in the cup of the device shall be divided by a firm stroke of grooving tool along the diameter through the centreline of cam follower
5. The cup shall be lifted and dropped until the two sides of the sample come in contact at the bottom of the groove. Record the no of blows (shakes) of the cup
6. Take a sample of soil from the cup into container and weigh it for moisture content determination.
7. Repeat all the steps at least for 2 more samples with different water content in order to plot moisture content vs. number of blows curve.



8. Oven dry the soil in the containers and record the weight.

N.B. Liquid limit of the soil is a moisture content which corresponds to 25 blows to close the grooved surface. We can read it from moisture content vs. number of blows curve.

- **Plastic limit (PL)**

1. Form ball of soil by mixing air dry sample with small water.
2. Mould the balls of soil between fingers and roll it between the palms of the hand until the soil starts to crack slightly at a diameter of about 3mm.
3. Divide the sample into 2 subsamples and weigh it.
4. Oven dries the subsamples in the containers and records the weight.

Calculation: $PI = LL - PL$

✓ **Compaction Test (Procter Test)**

Objective: To determine the maximum dry density and optimum moisture content

Table 7. Standard proctor test (light compaction test) - 2.5 k.g hammer

Method	Mold diameter	Material pass	Compacted layer	No.of blows/layer
A	101.6	4.75	3	25
B	152.4	4.75	3	25
C	101.6	19	3	25
D	152.4	19	3	25

Table8. Modified proctor test (heavy compaction test) - 4.54 kg hammer

Method	Mold diameter	Material pass	Compacted layer	No.of blows/layer
A	101.6	4.75	5	56
B	152.4	4.75	5	56
C	101.6	19	5	56
D	152.4	19	5	56

Prepare 5 representative samples each above 3 k.g materials passing

- I. 4.75 mm if cumulative % retained on 19 mm sieve is < 30% or
- II. 19mm if cumulative % retained on 19 mm sieve is $\geq$ 30%



Test procedure

1. Mix the sample thoroughly with a proposed amount of water which increases gradually from first to last specimen
2. Place a quantity of well mixed soil in compaction mould such that it occupies a little over $1/3^{\text{rd}}$ or $1/5^{\text{th}}$ of height of mould box when compacted.
3. Compact the soil uniformly using free fall of proper hammer by applying the specified no. of blows as shown above.
4. Repeat the same process for each layer
5. When all the layers are compacted, remove the extension collar from the excess soil, level the surface of the compacted soil to the top of mould using straight edge
6. Weigh the soil and the mould
7. Remove the compacted sample from the mould. Take a representative sample of soil for determination of moisture content
8. Re-do all the test process on the remaining four test specimens
9. Plot the compaction curve based on the results on five specimens which can be summarized as in the table below
- 10 .Read Maximum dry density (MDD) and Optimum moisture content (OMC) from the curve

Calculations

Table9. Proctor data format

A	Test	No.	1	2	3	4	5
B	Wt. of mould + wet soil	Grams					
C	Wt. of mould	Grams					
D	Wt. of wet soil	Grams					
E	Volume of mould	cm ³					
F	Wet density	gm/cm ³					
G	Container	Grams					
H	Wt. cont + wet soil	Grams					
I	Wt. cont + dry soil	Grams					
J	Weight of water	Grams					
K	Weight of container	Grams					
L	Weight of dry soil	Grams					
M	Moisture content	%					
N	Dry density	gm/cm ³					

Maximum dry density: MDD = _____ gm/cc Optimum moisture content: OMC = _____ %



Objective: To determine the California Bearing Ratio (CBR) and % Swell of a given soil type

Test procedure

I. Compaction

1. Assemble compaction mould and record its weight
2. In one of the three moulds i.e. for 10,30 and 65 blows, place a quantity of thoroughly mixed moist sample such that it occupies a bit over 1/3 or 1/5 of mould volume when compacted.
3. Compact the layer uniformly by applying the proper number of blows with free fall of rammer
4. Remove the rammer, fill the next layer and repeat the same process until final layer
5. Remove the extension collar, trim the extra sample and take a record of weight
6. Remove the sample from mould and take a representative sample for moisture determination.
7. Repeat all the above processes for the remaining two samples.

II. Soaking

1. Place filter paper on the top of each sample and fit perforated base plates on the top of the moulds
2. Assemble the moulds and place in empty soaking tank
3. Mount the dial gauge to read swell in place and adjust it to give a conventional zero reading and then fill the tank with water
4. Record reading of the dial gauge everyday
5. After 4 days of soaking, takeoff the dial gauge and its support, remove the mould assembly from soaking tank and allow it to drain for 15 min.
6. Carefully remove the surcharge discs, perforated swell plate and extension collar.

III. Penetration

1. Weigh the soaked sample before penetration.
2. Assemble the mould containing the sample on testing machine
3. Apply a seating force on the plunger, adjust the loading ring and penetration dial gauge reading to zero
4. Start the penetration of sample by the plunger at a uniform rate of 1 mm/min
5. Record the reading of loading ring for standard penetration dialgauge readings
6. Perform penetration test for all the samples

Calculations

$$\text{Swell (\%)} = (\text{final reading} - \text{initial reading}) / 127 * 100$$

$$\text{Load} = \text{dial} * \text{ring factor}$$

$$\text{CBR value}_1 (\%) = P_1 * 100 / 13.2$$

$$\text{CBR value}_2 (\%) = P_2 * 100 / 20$$

$$\text{CBR value (\%)} = \text{Max. (CBR value}_1 (\%), \text{CBR value}_2 (\%))$$

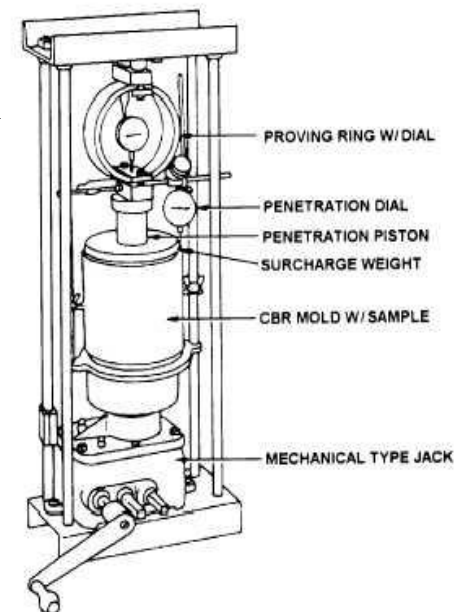


fig17.CBR machine



Where, P_1 and P_2 are plunger forces at 2.54mm and 5.08mm penetration respectively

Density of soil from CBR Mould (g/cm ³)		Before soaking	After soaking
Weight of soil + mould (g)	W_2		
Weight of mould (g)	W_1		
Weight of wet soil(g)	$W_2 - W_1$		
Volume mould(g)	V		
Wet density of soil (g)	$W_2 - W_1/V$		
Dry density (g)	$(W_2 - W_1)/V (1 + w)$		
Moisture Content			
Container	No.		
Weight of wet soil + container (g)	W_3		
Weight of dry soil + container (g)	W_2		
Weight of container (g)	W_1		
Weight of moisture (g)	$W_3 - W_2$		
Weight of dry soil (g)	$W_2 - W_1$		
Moisture content in (%)	$(W_3 - W_2)/(W_2 - W_1)$		

Plunger		
Penetration (mm)	Dial	Load
0.64		
1.27		
1.91		
2.54		
3.18		
3.81		
4.45		
5.08		
7.62		
9.16		

Table 10.CBR data format

✓ Unconfined compressive strength (UCS) of soil

Objective: To determine the Unconfined compressive strength (UCS) of a given soil type.

Test procedure

1. Collect necessary data from Procter test like MDD, OMC, and NMC.
2. Calculate mass of soil and volume of water which can fill UCS mold.
3. Mix the soil with water.
4. Place all moist sample in the UCS mold
5. Remove UCS mold and put molded sample by covering plastic.
6. Apply load on molded UCS sample by using soil UCS tester machine.
7. Read dial readings from machine and write on UCS format table.
8. Calculate stress according to the table format as shown below.
9. Draw stress vs. strain diagram and determine q_u



Table 11. UCS data format

DDR	LD R	$\Delta L = \text{DDR} * 0.00254$	$\text{LDR} * 1.85 / 2.2$	$\% \epsilon = \Delta L / L_o * 100$	Ao	$A_c = A_o / (1 - \epsilon)$	stress
0	0	0	0	0	24.63	24.6300864	0
10	1.3	0.0254	1.093181818	0.222807018	24.63	24.6850865	0.044
20	17.5	0.0508	14.71590909	0.445614035	24.63	24.7403328	0.595
30	20	0.0762	16.81818182	0.668421053	24.63	24.7958269	0.678
40	21.5	0.1016	18.07954545	0.89122807	24.63	24.8515706	0.728
50	22.5	0.127	18.92045455	1.114035088	24.63	24.9075654	0.76
60	23	0.1524	19.34090909	1.336842105	24.63	24.9638132	0.775
70	23	0.1778	19.34090909	1.559649123	24.63	25.0203155	0.773
80	20	0.2032	16.81818182	1.78245614	24.63	25.0770743	0.671
90	15	0.2286	12.61363636	2.005263158	24.63	25.1340911	0.502

$$q_u = 0.775 \text{ kg/cm}^2$$

$$C = q_u / 2 = 0.03875 \text{ kg/cm}^2$$

Strain at failure = 1.34%

✓ Linear shrinkage

Objective: To determine the linear shrinkage of a given soli.

Test procedure

1. The tests are conducted on soil samples passing 0.425mm (No. 40) sieve.
2. Place the soil sample on a mixing dish and thoroughly mix it with distilled water.
3. Place the mixed sample on Casagrande cup by squeezing to prevent air entrapment.
4. The soil in the cup of the device shall be divided by a firm stoke of grooving tool along the diameter through the centreline of cam follower
5. By trial and error determine the water content which make the
6. two sides of the sample come in contact at the bottom of the



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- groove, by using around 25 no of blows (shakes) of the cup.
7. Take a sample of soil from the cup into shrinkage container and shake by hand until the bubbles come out.
8. Air dry the samples to protect them from crack for some time according to the soil property.



Fig18. shrinkage mold

9. Oven dry the soil in the containers and record the linear length.
10. Linear shrinkage is equal to $((L_o - L_f) * 100) / L_o$, but L_o is equal to 14cm i.e. length of mold.

2.5.2.3 Procedures used In the Concrete Testing Laboratory

✓ Concrete mix design (ACI Mix design method)

The design of concrete mix is based on requirements and quality tests like:

- (a) Grade of concrete
- (b) Type of cement
- (c) Maximum nominal size of aggregate
- (d) Fineness modulus test coarse aggregate
- (e) Fineness modulus test coarse aggregate
- (f) Specific gravity test of cement
- (g) Specific gravity test of coarse aggregate
- (h) Specific gravity test of fine aggregate
- (i) Bulk density of coarse aggregate
- (j) minimum water cement ratio
- (k) Workability



Fig19: concrete mixer



ACI Mix design Procedure

1. Determine the slump depending on the degree of workability and placing condition. A concrete of the stiffest consistency (lowest slump) that can be placed efficiently should be used.
2. Determine the maximum size of coarse aggregate that is economically available and consistent with dimensions of the structure.
3. Determine the amount of mixing water for the given slump and maximum size of coarse aggregate from Table 4. This table also indicates approximate amount of entrapped air.
4. Determine the minimum water-cement ratio from the curve.
5. Determine the amount of cement per unit volume of concrete from steps 3 and 4. This cement content should not be less than the cement content required based on durability or some other criterion.
6. Determine the amount of coarse aggregate required for a unit volume of concrete from Table 5. The value thus obtained is multiplied by the dry rodded unit weight if the aggregate to get the required dry weight.
7. Determine the amount of fine aggregate. At completion of step 6, all ingredients of the concrete have been estimated except the fine aggregate. If the weight of concrete per unit volume is assumed, the required weight of fine aggregate is simply the difference between the weight of fresh concrete and the total weight of all other ingredients. An estimate of weight of fresh concrete can be made either by using Eq. 1 or Table 6

$$W_m = 10\rho_A(100-A) + \gamma_c(1 - \rho_A/\rho_C) - \gamma_w(\rho_A - 1) \quad (1)$$

Where W_m = **weight** of fresh concrete, kg/m³ ρ_C = specific gravity of cement (= 3.15)

ρ_A = weighted average specific gravity of combined fine and coarse aggregate
 A = air content, percent, γ_w = mixing water requirement, kg/m³ γ_c = cement requirement, kg/m³

8. Adjust the mixing water quantity based on the moisture content in the aggregate.
9. Check the calculated mix proportions by means of trial batches prepared and tested in accordance with the relevant IS specifications and make another trial, if necessary.



Table12.bulk volume of course aggregate

Maximum size of aggregate(mm)	Bulk volume of dray-rodded course aggregate per unit volume of concrete			
	Finesse modulus of fine aggregate			
	2.4	2.6	2.8	3
10	0.5	0.48	0.46	0.44
12.5	0.59	0.57	0.55	0.53
20	0.66	0.64	0.62	0.6
25	0.71	0.69	0.67	0.65
40	0.76	0.74	0.72	0.7
50	0.76	0.76	0.74	0.72
70	0.81	0.79	0.77	0.75
150	0.87	0.85	0.83	0.81

Table 13.Approximate water requirement for different slumps and maximum size of course aggregate(mm)

Slump(m m)	Water, Kg/m ³ of concrete for maximum size of course aggregate(mm)							
	10	12.5	20	25	40	50	70	150
Non air entered concrete								
30-50	205	200	185	180	160	155	145	125
80-100	225	215	200	195	175	170	160	140
150-180	240	239	210	205	185	180	170	-
Approximate % of entered air content	3	2.5	2	1.5	1	0.5	0.3	0.2
Air entered concrete								
30-50	180	175	165	160	145	140	135	
80-100	200	190	180	175	160	155	150	
150-180	215	205	190	185	170	165	160	
Recommended percent of average total air	8	7	205	5	4.5	4	3.5	

Table14. First estimate of course Aggregate(mm)

Maximum size of course Aggregate(mm)	Firest estimate of concrete weight (Kg/m ³)	
	Non-air concrete	entered Air entered concrete
10	2285	2190
12.5	2315	2235
20	2355	2280
25	2375	2315
40	2420	2355
50	2445	2375
70	2465	2400

✓ **Specific Gravity And Absorption Of Fine Aggregates (Aashto T 84)**

Objective: To determin the specific gravity and absorbtion capacity of fine aggregate.

Test Procedure

1. Thoroughly mix the sample and reduce the sample to the required size in accordance with AASHTO T 248. The sample size for this procedure is approximately 1000g of material passing the No. 4 (4.75 mm) sieve.
2. Dry test samples to constant weight in an oven set at $230 \pm 9^{\circ}\text{F}$ ($110 \pm 5^{\circ}\text{C}$). Cool the sample at room temperature for 1 to 3 hours. After the cooling period, immerse the sand in water at room temperature for a period of 15 to 19 hours.
3. Decant water from sample, avoiding loss of fines. Spread the sample on a flat, non-absorbent surface. Stir the sample occasionally to assist in homogeneous drying.
4. Calibrate a specific gravity flask pycnometer by filling with water at $73.4 \pm 3^{\circ}\text{F}$ ($23 \pm 1.7^{\circ}\text{C}$) to the calibration line. Record this weight as the weight of the pycnometer filled with water to the nearest 0.1g.
5. Place the SSD sand into the pycnometer (Figure 5) and fill with water (set at $73.4 \pm 3^{\circ}\text{F}$ ($23 \pm 1.7^{\circ}\text{C}$)) to 90% of pycnometer capacity.

Figure 24pycnometer

6. Bring the pycnometer to the pycnometer calibrated capacity with additional water.



Fig20.pycnometer operating



7. Determine the total weight of pycnometer, specimen, and water. Record the weight to the nearest 0.1g as Weight of Pycnometer with sample and water.

Calculations: Determine calculations based on appropriate formula for desired result as follows:

- A. Bulk Specific Gravity (Gsb): $Gsb = A / (B - C)$ Where: A = Oven dry wt .B = SSD wt. C = Wt. in water
- B. Bulk SSD Specific Gravity (Gsb SSD): $Gsb\ SSD = B / (B - C)$ % Abs = $[(B - A) / A] \times 100$
- C. Apparent Specific Gravity (Gsa): $Gsa = A / (A - C)$
- D. Absorption (% Abs): $\% Abs = [(B - A) / A] \times 100$

✓ **Normal consistency of cement (ASTM C 187, AASHTO T 129)**

Objective: To determine the amount of water required to prepare standard cement pastes, initial and final setting time of cement.

A 300 gm cement sample with a measured quantity of clean water is thoroughly mixed with in 3min. by using of a trowel.

1. Quickly from the cement pastes in the approximate shape of the ball with gloved hand by tossing 6 times from one hand to another a free path of about 6in (150mm) so as to produce a neatly spherical mass that may be easily interested in to the vicat ring mold.
2. Immediately after filling the mold level the past and lower the plunger gently and bring it in contact with the surface of the paste.
3. Release the plunger immediately.
4. Thirty seconds after releasing the plunger record its penetration.
5. The paste is said to be of normal consistency when the rod settles 10+1 mm below the original surface within thirty sec.
6. Repeat the above procedures varying the proportion of water until a paste of normal consistency is obtained.
7. The amount of water for normal consistency is then expressed as a percentage by weight of the dry cement.

Fig21.plunger



✓ **Setting time of normal cement (ASTM C191, AASHTO T 154)**

Objective: To determine the initial setting time and the final setting time of Figure 24 Vicatappa. Cement paste with normal consistency.

1. Proper cement paste of normal consistency

2. Remove the excess at the larger end by a single of sharpened trowels.
3. Invert the larger ring on the glass plate and slice off the excess pastes on the smaller end at a single oblique stroke by a sharpened trowel held at a slight take care not to compress the paste.
4. Immediately after molding, place the test specimen in the moist room and allow angle with the top of the ring. During the operation of cutting and smoothing
5. it to remain there except when determination of setting is being made. The specimen shall remain in the conical mold supported by the glass throughout the test period .allow the specimen to remain in the moist cabinet for 30 min after molding without disturbing. Lower the needle until it rests on the surfaces of the specimen.
6. Tighten the screw and set the indicator at the upper end of the setting time initial reading. Release the rod quickly and allow the needle to settle for 30 sec .no penetration is made closer than 10mm from the inside of the mold (ASTEM 95).
7. Determine the penetration of the 1mm (diameter) needle at this time and every 10min thereafter until penetration of 25mm or less is obtained and record the results of all penetration testes.
8. Interpolate between the results obtained to determine the time when a penetration of needle does not sinks visibly in to the paste.



Figure 22.Glimore apparatus while testing

✓ **Silt content of sand**

Objective: To determine the silt (finer than No 200 sieve) content in sand.

1. Take graduated cylinder or jar having a capacity of greater than 100ml.
2. Pour 30ml of sand to the cylinder.
3. Fill approximately 4/3 of the cylinder with water.
4. Shake the cylinder vigorously for a about a min
5. Leave the cylinder for about an hour to allow them to settle on the layer of the sand.
6. Measure the amount of fines forming a separate layer on the top of the washed sand.

✓ **Workability of mortar**

Objective: To determine the workability or fluidity of fresh mixed mortar.

1. Prepare cement sand and water with given proportion.
2. Mix cement and sand for about a min (dry mix) then add the required amount of water and mix for about two min.
3. Carefully wipe the flow table tope clean and dry then place the flow mold at the center of the table.
4. Fill the mortar to the mold with three layers and tamp 25 times each layer with a tamping rod. The tamping pressure shall be just sufficient to ensure uniform filling of the mold.
5. Cut off the mortar to a plane surface, slush with the top of the mold by drawing the straight edge of the flow mold.
6. Wipe the table top clean and dry being especially careful to remove any water from around the edge of the flow mold.
7. Lift the mold away from the mortar and then drop the table 25 times within 15 sec through a height of 13mm.
8. Using the caliper determine the flow by measuring the diameter of the mortar along the lines on the tabletop(take 4 reading)

✓ **Compressive strength of mortar**

Objective: To determine the compressive strength of mortar.

1. Immediately following completion of the flow tests return the mortar from the flow table to the mixing dish. Quickly scrap the dish and then remix the entire batch for 15 sec.
2. Fill the mortar in to the cube mold with three layers and tamp each layer 25times with tamping rod. The tamping pressure shall be just sufficient to ensure uniform filling of the mold.



Fig23.mortar mold

3. After 24 hrs remove the mortar cubes from the mold and cure them in water.
4. Determine the compressive strength of the mortars at the ages of 3, 7 and 28 days.



✓ **Sieve analysis for fine aggregate(AASHTO T 27-93)**

Objective: To determine the particle size distribution of course aggregate.

1. Weight 2kg of a sample of fine aggregate.
2. Quarter the sample using a riffle box.
3. From the quartered sample take 500gm.
4. Weight the empty sieves and record the data.
5. Place the pan to the bottom of the sieve shaker and put the other sieve in to the pan with increasing opening size of the sieve.
6. Place the 500gm of sample on the top of sieve
7. Shake the sample about 2 min in a sieve shaker.
8. Weight each together with the aggregate retained on it
9. Calculate the weight retained on each sieve.

✓ **Procedure for grading coarse aggregate(AASHTO T 27-93)**

1. Weight 20kg of sample of coarse aggregate.
2. Select a representative sample by quartering.
3. From the quartered sample take 2kg.
4. Weight the empty sieve and record the data.
5. Place the 2kg of sample on the top sieve.
6. Shake the sample about 2 min in a sieve shaker.
7. Weight each sieve together with the aggregate record on.
8. Calculate the weight retained on each sieve.



Fig24.fine sieve shaker

❖ **Auto clave Expansion of cement (ASTM C 151-84,AASHTO T 107)**

Objective: to determine the response of the cement when it is under high pressure (295PSI) and temperature condition.

Test Procedure

1. The mass of cement used for the pest is equal to two times the cement used for setting time.
2. Tamping 25 times in two layers in the Autoclave mold andputting for 24hrs in moist place is the next step.
3. After 24hrs the initial length is measured by length comparator. And putting the specimen in Autoclave tester machine for 3hrs after adding 500ml distilled water under pressure of 295PS.
4. After cooling the specimen for 30mites the final length is measured. Finally AEX is determined by calculating the percent increase in length. And AEX value shall be between 0.02&0.8%.

❖ **Slump test (Workability of concrete)(AASHTO T 119-93)**

Objective:To determine workability of concrete.

1. Make sure that cone is clean, free from hardened concreteand dry inside on the base plate, which must also be clean.
2. Stand with your feet on the foot rests.
3. Using the scoop fill the cone to about one third of its height and rod this layer of concrete exactly 25 times using the tamping rod.
- 4.



❖ **Compressive strength of concrete(AASHTO T 022-92)**

Objective: To determine the compressive strength of concrete.

1. Use the same concrete mix for workability is determined.
2. Prepare a cubical mold (15*15*15) cm³ and oiled them in order to easily demanding of the concrete cubes.
3. Fill the concrete in the cubical mold and vibrate in order to remove air bubbles for about 30 sec.
4. Smooth the surface and remove the excess concrete on the cubes mold by using spatula, and also register mixing date at the top of the concrete.
5. After 24hrs remove the concrete from the mold and cure in water till the required date.
6. Load the concrete specimen to failure at 3, 7 and 28 days of age by using testing machine and record the failure loads.
7. Calculate the stresses at failure by dividing the failure lodes by respective contact areas with the load (the compressive strength).

❖ **Unconfined compressive strength (UCS) of drilled rock core**

Objective: to determine the compressive strength of bed rock which are drilled from ground at different depth.

1. The cylindrical sample is prepared with height equal to two times the diameter of drilled rock.
2. The prepared sample is soaked in water for 24 hrs to consider worst condition then the unconfined compressive strength of the sample is determined, by putting the rock sample in compressive strength tester machine and the maximum load which can be carried by the rock is determined.
3. Finally, UCS is load divided by cross sectional area.

✓ **Compressive strength of blocks**

Objective: To determine the compressive strength of concrete blocks.

1. Measure the dimension of each block for a check.
2. Make the concrete surface, with the testing machine, of each sample plane by chapping with 1:1 mortar of 2 to 3mm thickness. The cape shall be aged for at least 24 hrs before the samples are tested.
3. Place samples in a position such that the load is applied in the same direction as in service and the sample is centralized b/n the pressure surfaces.
4. Increase the compressive force at the rate of 0.2 to 0.5 N/mm² (2 to 5kg/cm²) until the sample breaks.
5. Record the maximum load (load at rupture).



Fig25. Autoclave machine



Fig26. Compressive strength machine



Fig27. Drilled Rock

✓ **Re-bar test for steel(AASHTO T 68-96)**

Objective: To determine tensile strength, yield strength, mass per meter (Kg/m) and reduction of area of Reinforcement bar which have different diameter. It is a general test which is used to determine different qualities of Reinforcement steel bar.

1. Sampling is done by taking three samples for each diameter randomly not less than 70cm in length.
 2. Test procedure is started by measuring the length and mass of each sample.
 3. Then the maximum load which can be resisted by the bar is determined by using tensile strength tester machine.
 4. Finally ultimate tensile strength, yield strength, mass per meter (Kg/m), elongation and reduction of area are calculated.
 5. There are two different types of steel Grades which are G40 and G60. If the steel is G40 the minimum yield strength is expected to be 300Mpa and if the steel is G60 the minimum yield strength is expected to be 500Mpa. Also the minimum elongation is 12 percent.
- TCDSCO is among known companies in the country which have a machine to test bars of high diameter and of course a machine which tests hollow steels.



Figure 28 .tensile strength of steel testing machine

2.6 Challenges I faced while I was performing my work

While I was working in TCDsco we face different challenges both in design and in laboratory section. Most of the problems of the company came from old age of the materials and machines used in the company. Also poor attention for maintenance contributes a lot for most challenges we face in the company. The other challenge source of the company is inability to update the machineries and software used in the company. Even the company has such sources of problems, but the company has highly experienced and qualified workers who can do accurate and standardized quality work by facing and giving appropriate solution for each and every problems.

Challenges we face while we were working in TCDsco are the following:

- Civil designer software is the oldest version and it may stack while working
- While working ACV test , the material was highly crushable and it crushed rapidly fill all voids before ten munities and the machine can't apply 400kN.



- High quantity of dust particle was produced and may cause health problem.
- Auto clamp expansion sample is broken after it is casted and it was difficult to measure the initial length to proceed the test.
- Manual balance of Specific gravity and hydrometer test is located near the tensile strength testing machine and the vibration caused by the machine decrease accuracy of the result of the test.
- Shrinkage samples are broken after oven dry.
- UCS sample of soil was broken when the sample is removed from cylindrical mold.
- Since we didn't take Highway II, I couldn't fully understand different lab tests specially Asphalt tests.
- Because of shortage of workers in the laboratory section, we face high work burden.
- Some times there might not be electric power which affect working duration.
- Lack of safety is not the least challenge. The work is so hard it is not the hardness only the feature of the laboratory work. A lot of dusts and being dirty is also typical feature of laboratory work. This exposure to lung diseases there are a lot of chemicals for the test which are very dangerous for health including sulfur, mercury, ethylene and so on.

2.7 Measures taken to overcome Challenges faced

Measures taken to overcome Challenges we face while we were working in TCDSC are the following:

- For the third challenge we mentioned above additional spacer is added and the test is repeated by other sample.
- Repetitive weighing of samples for accuracy.
- I used laboratory safety equipment's to protect my health by myself.
- Manual balance is used,

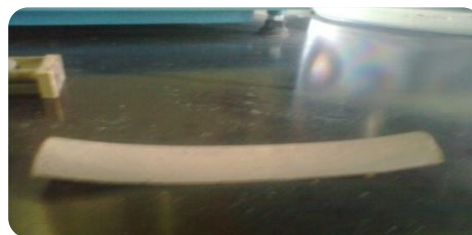


Figure 29. Manual balance and Shrinkage sample



- Since Auto clave expansion test has two trials it is continued by one trial. And for the accuracy the test is repeated.
- Specific gravity and hydrometer tests are done as much as possible when the machine is not working.
- Shrinkage samples put on air to dry before they are send to oven.
- For the UCS samples additional water is added to the sample and the sample is putted in plastics to increase the cohesive nature of the soil. Also the mold is painted by oil well.
- Maintaining some of machines is on progress.

3. SAFETY REPORT

- ◆ ***High sort of care is been taken while I was in a sections which are exposed to some chemicals, machines and others as well. It is unquestionable that in a such section there will be a harmful things be there, but I myself also take care of things which harms my health as well.***

4. Benefits of the internship

For something that takes inputs there is something in return, a benefit. In my internship too, there were some benefits those are gained accordingly. While I was working in TCDSC in general I have gained the following important and interesting benefits, which are:

- Practical skills
- Theoretical knowledge
- Interpersonal communication skills
- Team playing skills
- Leadership skills
- Work ethics related issues
- Entrepreneurship skills

These listed benefits are discussed below briefly:

4.1. Practical Skills

When we started working in the company everything was new for me. I had only the theoretical knowledge of the works. It was really fascinating and inspiring to see and experience the lessons we have been learning for the past there years. So I tried to experience and learn every work as much as we can. I tried to learn every aspects of the work both technical and non-technical terms. From our internship time in TDCsco we deserve high practical skill in design



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and laboratory sections of the company. Practical skills i gained in the company are listed below;

- Making Geometric design of the road by using Civil Designer software
- Using different design manuals for design of road like ERA, AACRA and TCDSC manuals for practical design
- Using different software like Auto Cad, Civil Designer, Excel and
- Compiling and making full drawings of road design
- Preparing samples for different testes
- Using different laboratory machines and apparatuses
- Using different laboratory manuals like ASHTO,BS,ASTM and ACI for practical work
- Executing different tests by following different standards and manuals
- Calculating results of different tests
- Analyzing results of different tests
- Reporting results of different tests

4.2. Theoretical Knowledge

Since the practice depends first on theory, it was easy to correspond with each other. It is not very challenging to change the theory into practice. Theoretical knowledge is dependable on principles, logic and calculations. It is interesting when the theoretical knowledge & the practice meet exactly as you wanted to.

In my internship time I have gained so many, theoretical knowledge's in addition to practical skills. Since I work in the design and laboratory sections of the company, most of the theoretical knowledge I learn and read is applied effectively. And these help me to exercise and understand in unforgettable way because I was designing and testing samples by my selves. These were interesting to us and increase our intention towards the work. This and other different reasons make me to have rich theoretical knowledge and experience.

The company has a well-organized library which is full of books. Anyone who is in the company can access it. we were using this opportunity. This led us to know a lot. Additionally the professional workers specially the youths were so enthusiastic to show and tell briefly anything new for me additional to brief answer for my questions. There was time to perform a test by ourselves which is encouraged us which develop our self-confidence. The other way that increase our theoretical skill was some of the workers made a mistake on purpose and expect us to correct and sometimes they asks us what to do next and they expect us to answer and judge us. Which is a good way to make a person follow attentively? We personally want to thank them



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for being such a good teacher. This internship gave us much knowledge regarding highway design in design division and concrete, soil, aggregate and asphalt tests in geotechnical division.

Generally speaking, my theoretical knowledge got strengthens more by these practical techniques invested on laboratory and Design. This is because I had to refer every time when I came across a problem.

4.3. Interpersonal Communication Skills

Interpersonal communication is a way of communication that a person have with other people who might have contact with. Meeting with the staffs was a little tough. Then after time has passed we let ourselves to them by reasonably talking on issues those are related to the laboratory and design. Then step-by-step when we got into the work, there comes the opportunity to communicate on work related talks.

The other relation we involved was with interneers who were come from different universities with different backgrounds. First day of our meeting it possessed a great effort for nice interaction because of background, hobby and other similar things. But this situation changed because we all are young. Our relation developed with days and we investigate common friends.

Every day we wear connecting with specific working class. This improves understanding the thinking of the peoples around us. And finally we wear the one who communicate with everyone in the laboratory and design. This was one of the main things that helped us to improve our practical skills.

4.4. Team Playing Skills

Team playing skill is a skill of a person to work with other people co-operatively. This skill was developed easily and rapidly. It begins when we were in campus. Some assignments given were done in groups. This helps us to handle different characters of the persons we worked with.

Our work tasks need lot of cooperation and communication with one another specially laboratory section because laboratory testes need high degree of coordination with accuracy. The output result of one is input of the another. In each and every tasks contribution of every individuals adds a value for the best output. While we were doing this different tasks, ideas where rose and there were arguments between us.

Even each work task was done and completed by working as a team. For each and every test, starting from sample preparation up to reporting the final result, accurate working ability, good



coordination and high care for the work are the basic requirement. This listed factors and other conditions of the work highly upgrade our team playing ability.

4.5. Leadership Skills

Leadership is a skill to guide, control and monitor peoples. In our internship time in TCDSCo different works help us to improve and exercise our leadership ability. Leading a work came with responsibility. And the works give us responsibility of performing different tests and designs accurately with other peoples. Leading this tests and designs was our task, through this time we exercise our leadership ability. And these highly contribute to the process of improving our leadership skill.

Here in our working place, it is occupied with highly experienced and qualified person, this person has a leading responsibility which can teach us how to lead the workers under his/her control. Among very hard and difficult tasks in the construction field it is also very difficult to lead a lot of employees. It would be one of the best ability of a good engineer. due to lack of knowledge and experience or being out of mind for some reason, someone might runs a wrong procedure or wrong reading. The tests which are performed there are highly risky, a little mistake gives completely wrong value. Correction of this mistake is expected from the engineer. This thing allowed us to foresee the future responsibility that would lay on our shoulder.

4.6. Work Ethics Issues

- **Punctuality**:-arriving on time at work was necessary since it was part of my job to manage, control, monitor and supervise the portion of the task i was doing. In laboratory punctuality is directly related with accuracy, correctness and finally with result of test. Being not punctual means reporting incorrect result, this is because most of laboratory tests are related with time, and arriving on time in laboratory is must to have accurate and correct test result. All this helped me to understand how punctuality is important in work place.
- **Responsibility**: - I have taken responsibility to the jobs I were doing and the equipment's. Responsibility in our work place was important work Ethics, because I was responsible for all tasks I perform. This helped me to understand the importance of responsibility.
- **Office disciplines**- in work place i don't have to disturb the working atmosphere. For example abstain from opening loud voice, loud music, songs and things which disturb other worker's working mood.



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- **Reliability**- The worker should be qualified for the part he is supposed to be performing. He/she must have appropriate skill and knowledge for the task assigned.
- **Honesty**- Regarding this value each worker regardless of its status should abstain from bad behaviors such as cheating, bias, corruption etc..
- **Cooperation**- Each worker should interact and cooperate with each other while working. That is because it is through such system problems could be easily solved, which facilitate the work flow in the company.

4.7. Entrepreneurship skills

By now in our country construction is the leading business relative to other new business. Since our country is developing country the country need different more civil facilities to become developed country, which need high participation of Civil Engineers starting from design up to construction. Construction needs high investment which delivers high profit for both contractor and client. We saw and hear different construction related problems. Understanding this make me to think more about being Entrepreneur and we saw different construction firms which work together with TCDS Co.

5. Conclusion

TCDS Co is a highly experienced independent company since 1987. The major part of the company's staff holds different professionals of Civil Engineering fields including Highway Engineers, Structural Engineers, Geotechnical Engineers, Geologists, Hydrologists, Photogrametrists, Surveyors and so on. The company also includes Chemists, Economists, laboratory technicians, specialists in construction management, preparation of specifications and contract documents, Computer application and other supporting staffs other than non-professional laborers. The company involved in many major construction projects including *Bole international airfield* and *Addis Ababa ring road*.

6. Recommendation for the company

- ❖ Try to keep highly professional skilled man powers of the company; this enables the firm to attend projects with a lot of speed and accuracy.
- ❖ Substitute workers rapidly as soon as possible when they resign from the company.
- ❖ Use additional modern computers, machineries and equipment's, this will enable the projects to be finished with a lot of speed and will save a lot time and facilitate the work flow in the company. And also has the advantage of using the machineries for a longer period of time..



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- ❖ Give proper and enough safety equipment's especially for laboratory workers.
- ❖ Facilitate some short courses and trainings to the workers to update the with recent technologies.
- ❖ Make strong communication between different departments of the company each other.
- ❖ Implement a Generator to run all the tasks quickly for the customer's satisfaction when there is no electric power.



7. Reference

- ❖ **ASHTO Material Test Manual**
- ❖ **ASTM Material Test Manual**
- ❖ **BS Material Test Manual**
- ❖ **ERA Geometric Design Manual**
- ❖ **ACI Manual**
- ❖ **TCDSCo Company profile**