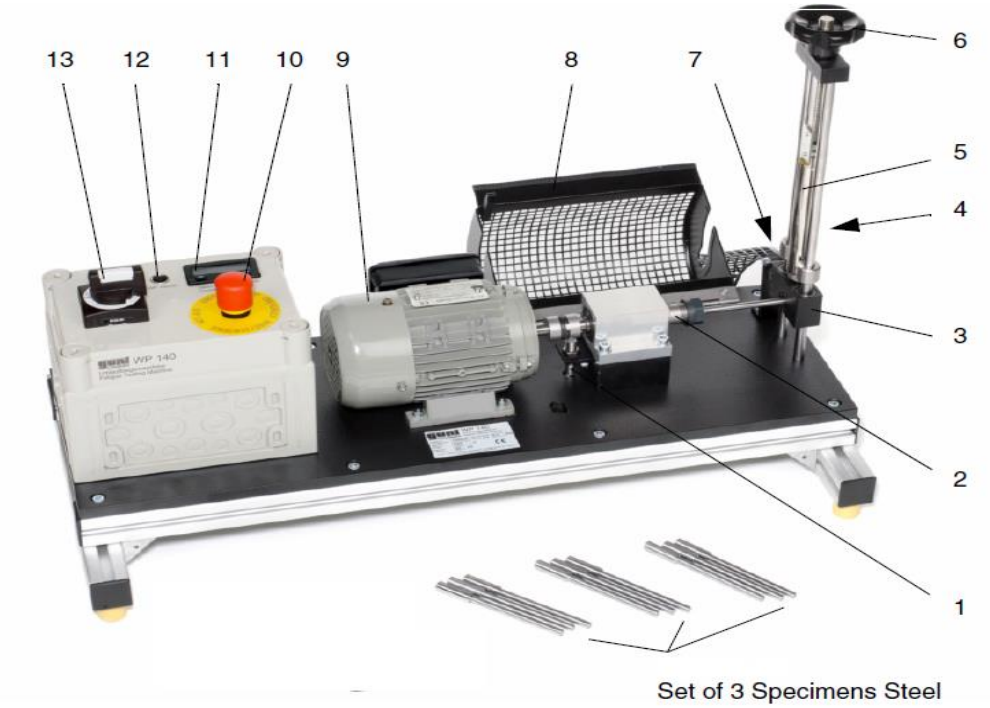
(CLO 3.3, CLO 3.4, CLO 4.1, CLO 4.2, CLO 4.3)

MODEL LAB REPORT
FATIGUE TESTING MACHINE

Object: -

a) To draw the S-N diagram by with the help of fatigue test.
b) To study the effect of various curvature radii and surface qualities on fatigue.



Apparatus

1. Proximity sensor.
2. Spindle with specimen receptacle.
3. Floating Bearing.
4. Scale.
5. Spring Balance.
6. Hand Wheel.
7. Proximity Switch.
8. Protective Hood.
9. Drive Motor.
10. Emergency off switch.
11. Counter.
12. Connection socket. (optional)
13. Motor Protection switch.
14. Set of Specimen

Theory: -

When a metal is subjected to repeat cycles of stress or strain, it causes its structure to breakdown ultimately leading to fracture. This behaviour is called fatigue. It is generally responsible for a large percentage of failures in various mechanical and automotive components. Fatigue is a form of failure that occurs in structures subjected to dynamic and fluctuating loads. Under these circumstances, it is possible for failure to occur at a stress level considerably lower than the yield strength for a static load. It generally occurs after a lengthy period of repeated stress or strain cycling.

The process of fatigue failure is characterized by three specifics steps.

a) Crack initiation. b) Crack propagation. c) Final failure.

In the moving fatigue testing machine, a rotating specimen is clamped on one side is loaded with a concentrated force. As a result an alternating bending stress is created in the cylindrical specimen. Following a certain number of load cycles, the specimen will rupture as a result of material fatigue. With this machine, it is possible to demonstrate the basic principles of fatigue strength testing, including the production Stress-No. of cycles diagram **(S-N diagram)**. The specimen is subjected to a pure reversed bending stress in the machine. With different specimen shapes, it is possible to show the influence of the notch effect and the influence of surface quality on fatigue strength.

Specimen Material = **C35E (Alloy of Cr + Mo + Ni)**

Procedure: - Part (a)

1) First of all fold up the protective hood.
2) Relieve the load device using the hand wheel by moving the floating bearing down to the bottom. Remove any specimens which may be in position.
3) Lightly tighten the union nut on the collets chuck.
4) Fold down the protective hood and loosen the emergency off switch.
5) Reset the counter using the **RST** button. The counter must display zero.
6) After checking all these parameters, the experiment can begin.
7) Make sure that the floating bearing must be at the height of the spindle.
8) Insert the test bar in the floating bearing of the load device.
9) Afterwards insert the test bar in the collate chuck and push in as far as the end stop and carefully tighten the collets chuck using a wrench.
10) Now check the concentricity of the specimen by rotating the spindle by hand and fold down the protective hood. ***(Remember the unit can only be placed in operation if the protective hood is correctly closed)***
11) Loosen the emergency off switch and quickly apply the load by rotating the hand wheel.
12) Read off the load from the scale on the spring balance.
13) Reset the counter using the **RST** button in order to begin counting.

14) The motor stops automatically when the specimen ruptures. Read off the number of load cycles from the counter and record it in the observation table.
15) Repeat the experiment for the next specimen.
16) The stresses are entered over the endurance in the semi-logarithmic diagram i.e. the attached worksheet and draw the graph between stress and no. of cycles. This graph is called S-N diagram.

Procedure: - (Part b)

The procedure is similar to the previous test except that you need to switch off the motor after completion of the required number of cycles.

Results: -

a) Number of load cycles for test bar under different loads

No.	Load (N)	Stress σ (N/mm^2)	Endurance (n)	Duration (min)
1	200	400	14030	5
2	170	340	48800	17
3	150	300	167000	60
4	130	260	455000	162
5	120	240	1280800	457

b) The Influence of Various Curvature Radii and Surface Qualities:-

Test bar # 1 → Small radius and smooth.
Test bar # 2 → Large radius and smooth.
Test bar # 3 → Large radius and rough.

The following numbers of load cycles are achieved until the specimen ruptures.

No.	Load (F)	Stress ($\sigma_{a)}$	Specimen 1	Specimen 2	Specimen 3	Average
1	200 N	400 N/mm^2	11.300	11.300	11.700	**11.433**
2			17.150	17.300	23.700	**19.383**
3			14.030	12.800	16.300	**14.376**

Number of load cycles $\mathbf{N}_{(\pm 200)}$ to rupture.

Discussion:-

The results verify the theory. Fatigue strength is the highest stress that a material can withstand for a given # of cycles without rupture. There are two types of fatigue.

1. Normal Fatigue.
2. Thermal Fatigue.

Fatigue failure is catastrophic means something happens suddenly. Endurance can be defined as # of cycles which the specimen rotates before it fails. Endurance and # of cycles are same. Crack Initiation is the starting of crack develops in the weaker part of the specimen. Crack

propagates linearly from the centre of initial crack and travels in the same direction until final rupture. The factors that may effect on the fatigue life of specimen are magnitude of stress, quality of surface, material, surface roughness, surface treatments, imperfection in assemblies of components etc. We can upgrade the fatigue life and surface hardness of steel alloys by heat treatment (carburizing).Thermal fatigue is a specific type of fatigue failure mechanism that is induced by cyclic stresses from repetitive fluctuations in the temperature of equipment. Our experiment does not belong to thermal fatigue since mechanical load was applied. When the specimen has good surface finish, it has higher fatigue life.

Conclusion: -

With an identical curvature radius, the specimen with the smoother surface (i.e. test bar # 2) has a higher endurance than the one with the rougher surface **(i.e. test bar # 3).**

Abstract: -

In this experiment, we observed the fatigue behaviour of steels and the effect of various curvature radii and surface qualities on fatigue. The specimen were put under high speed cyclic loading in the fatigue testing machine also known as Wohler machine. The test continues until rupture of specimen.

References / Bibliography:-

1. Fundamentals of Materials Science & Engineering by William D Callister, Jr & David .G. Rethwish, John Wiley & Sons, Inc., 2007, 3rd Edition.
2. http://en.wikipedia.org/wiki/fatigue