

LABORATORY MANUAL

BASICS OF MECHANICAL
ENGG.

ME-107-F

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EXPERIMENT No.-1

AIM :- To study the Cochran and Babcock & Wilcox Boilers.

APPARATUS USED :- Model of Cochran and Babcock & Wilcox Boilers.

THEORY :- A closed vessel in which steam is produced from water by combustion of fuel. According to A.S.M.E, “combustion of apparatus for producing or recovering heat together with the apparatus for transferring the heat so made available to the fluid being heated and vaporized. The primary requirements of steam generator or boiler are:

1. Water
2. Water drum
3. Fuel for heating

TYPES OF BOILERS :-

- a. Water tube boiler
- b. Fire tube boiler

In the water tube boilers, the water are inside the tube & hot gases surrounds the tubes.

The various water tube boiler are following :

- (i) Babcock & Wilcox boiler
- (ii) Sterling boiler
- (iii) Lamont boiler
- (iv) Loeffler boiler
- (v) Benson boiler
- (vi) Velox boiler

The various fire tube boiler are following :

- (i) Lancashire boiler
- (ii) Locomotive boiler
- (iii) Scotch marine
- (iv) Cochran boiler
- (v) Cornish boiler

COCHRAN BOLIER :-

SPECIFICATIONS :-

Size = 1m. dia. X 2m. high (evaporation 20 kg/hr)

= 3m.dia.x 6m.high (evaporation 3000kg/hr)

Heating surface = 10 to 25 times grate area

Heating pressure = upto 20bar

Efficiency = 70 to 75 %

CONSTRUCTION AND WORKING:

Simply vertical boilers of the fire tube type find favour in small plants requiring small quantities of steam and where the floor area is limited. The most common application are steam rollers, pile drivers, steam shovels, portable hoisting rigs and certain other mobile applications.

The coal is fed through the fire door to the grate with fire bars on it. The boiler can also work as an oil fired unit by fitting an oil burner at fire door. The grate is then dispensed with and a lining of fire bricks are provided beneath the furnace. The furnace has no riveted seams exposed to flame and is pressed hydraulically from one plate to finished shape. This makes the furnace suitable to resist the intense heat produced by the combustion of fuel.

The coal, on burning, produces hot flue gases and these hot products of combustion from the fire box enter through the small flue pipe into the combustion chamber which is lined with fire bricks on the outer wall of the boiler. The dome shaped furnace and the combustion chamber prevent the loss which could otherwise occur because of combustion being retarded and much unburnt and combustible matter leaving the furnace. The unburnt fuel is deflected back to the grate and complete combustion is achieved in combustion chamber where high temperatures are maintained.

The hot gases passing through the horizontal smoke tubes give their heat to the water and in doing so convert water into steam which gets accumulated in the upper portion of the shell from where it can be supplied to the user. The flue tubes are generally of 62.5 mm. external dia. And are 165 in number. The crown of the shell is made hemispherical in shape which gives the maximum space and strength for a certain weight of material in the form of plates. Finally the flue gases are discharged to the atmosphere through the smoke box and the chimney.

BABCOCK & WILCOX BOILER :-

The water tube boilers are used exclusively, when pressure above 10bar and capacity in excess of 7000kg./hr. is required.

DIMENSION & SPECIFICATIONS :

Diameter of the drum	1.22 to 1.83m.
Length of the drum	6.096 to 9.144m.
Size of the water tubes	7.62 to 10.16cm.
Size of the super heater tubes	3.84 to 5.71cm.
Working pressure	40bar (max.)
Steaming capacity	40000kg./hr.(max.)
Efficiency	60-80%

CONSTRUCTION & WORKING :-

Babcock & Wilcox boiler with longitudinal drum. It consists of a drum connected to a series of front end and rear end header by short riser tubes. To these headers are connected a series of inclined water tubes of solid drawn mild steel.

The inclination of tubes to the horizontal is about 15 degree or more. A hand hole is provided in the header in front of each tube for cleaning & inspection of tubes. A feed valve is provided to fill the drum and level of water indicates by water level indicator. Fire is burnt on the grate. The hot gases are forced to move upwards between the tubes by baffle plates provided. The water from the drum flows through the inclined tubes via down take header & goes back into the steam the steam space of the drum. The steam then enters through the anti-priming pipe and flows in the super heater tubes where it is further heated and is finally taken out through the main stop valve and supplied to the engine when needed.

In the cross drum there is no limitation of the number of connecting tubes. In case of cross drum:

Pressure ----- 100 bar

Steaming capacity -----upto 27000kg./hr.

APPLICATIONS :-

The steam generated is employed for the following purpose :

1. For generating power in steam engines or steam turbines.
2. In the textile industries for sizing & bleaching etc. and many other industries like sugar mills, chemical industries.
3. For heating the building in cold weather & for producing hot water supply.
4. Steam turbine propelled ships and other marine vessels.
5. Agriculture field machineries, saw mills etc.
6. Steam locomotive.
7. To study steam to the steam engine for driving industries hoists, road rollers, in road constructions, pumps in coal mine.

PRECAUTIONS :-

- Do not feed water fully the drum.
- Water level should be checked properly.
- Pressure should not be over the rating pressure.
- Clean the boiler time to time.
- Boiler operator should be present there.

VIVA-QUESTIONS :-

- What is the main pre-requirement for boilers ?
- How many types of water tube boilers ?
- How many types of fire tube boilers ?
- How many types of mountings in boiler ?
- What is the functions of mountings ?
- How many types of accessories in boiler ?
- What is the functions of accessories ?
- Why use super heater & air-pre-heater ?

EXPERIMENT No.-2

AIM:- To study the working and function of mountings & accessories in boiler.

APPARATUS USED: - Model of Mounting & accessories in boiler.

THEORY :- For efficient operation and maintenance of safety, the boiler equipped with two categories of components and elements.

First categories include the fittings which are primarily indicated for the safety of the boiler and for complete control of the process of steam generation. These units are called mountings. The mounting from an integral part of the boiler and are mounted on the body of the boiler itself. The following mountings are usually installed on the boiler.

1. Two safety valve
2. Two water level indicators
3. Pressure gauge
4. Fusible plug
5. Steam stop valve
6. Feed check valve
7. Blow-off cock
8. Man and mud hole

Second categories include the components which are installed to increase the efficiency of the steam power plants and help in the proper working of the boiler unit. These fitting are called boiler accessories. The following accessories are given below.

1. Air pre-heater
2. Economiser
3. Super heater
4. Feed pump and
5. Injector

FUNCTION, LOCATION AND WORKING OF MOUNTINGS AND ACCESSORIES:-

A) SAFETY VALVE:- The function of the safety valve is to permit the steam in the boiler to escape to atmosphere when pressure in the steam space in the boiler. The safety valve operates in the principle that a valve is pressed against its seat through some agency such as sturt, screw or spring by external weight or force. when the steam force due to boiler pressure acting under the valve exceeds the external force, the valve gets lifted off its seat and some of the steam rushes out until normal pressure is restored again.

The commonly used safety valves are given below:-

- i) Dead weight safety valve
- ii) Lever safety valve
- iii) Spring loaded safety valve
- iv) High steam- low water safety valve

B) WATER LEVEL INDICATOR:- The function of the water level indicator is to ascertain constantly and exactly the level of water in the boiler shell. It is fitted in the front of the boiler from where it is easily visible to the operator.

The unit consists of a strong glass tube whose ends pass through stuffing boxes consists of heat resisting rubber packing to prevent leakage steam and water. The flanges are bolted to front end plate of the boiler, the upper flange being fitted to the steam space and the lower to water space in the boiler. There are two cocks namely steam cock and water cock which communicate the boiler shell spaces to the gauge glass tube. When the handle of the cocks are vertical, they are in operation and the water level in the tube corresponds to water level in the shell. A red mark on the glass tube indicates the safe water level.

C) FUSIBLE PLUG:- The function of the fusible plug is to extinguish the fire in the event of the boiler shell falling below a certain specified limit. We know that when the water on heating transforms into steam, the level of water in the boiler falls down. If the water is not replenished and the steam generation continues then the parts, which have been uncovered by water uncovered by water may get overheated and subsequently are melted. To safeguard against this eventuality we use fusible plug.

The fusible plug is inserted at the box crown or over the combustion chamber at the lowest permissible water level.

D) PRESSURE GAUGE:- Each boiler has to be provided with a pressure gauge, which record the pressure at which the steam is being generated in the boiler.

The gauge is usually mounted at the front top of the boiler shell or drum. The gauge has to be clearly visible to the attendant so that he can easily record the pressure reading.

E) BLOW OFF COCK:- The blow of cock serves to drain out the water from the boiler periodically for any one of the following reasons:-

- 1) To discharge mud, scale and other impurities which settle down at the bottom of the boiler?
- 2) To empty the boiler for internal cleaning and inspection.
- 3) To lower the water level rapidly if the level becomes too high.

The unit is fitted at the lowest portion of the boiler. It may be mounted directly to the boiler shell or through an boiler elbow pipe, which is fitted to the boiler shell.

F) FEED CHECK VALVE:- The feed check valve has the following two functions to perform:-

1. To allow the feed water to pass into the boiler.
2. To prevent the back flow of water from the boiler in the events of the failure of the feed pump.

G) STOP VALVE:- The function of the steam stop valve is to shut off or regulate the flow of steam from the boiler to the steam pipe or from the steam pipe to the engine. When used for the former purpose, it is called junction valve. Usually the junction valve means a regulating valve of larger size and a stop valve refers to a regulating valve of smaller size.

The junction valve is mounted on the highest part of the steam space of the boiler and is connected to the steam pipe, which carries the steam to the engine.

H) MAN HOLES:- These are door to allow men to enter inside the boiler for the inspection and repair.

I) AIR HEATER:- Air heater or air pre-heater are waste heat recovery device in which the air on its way to the furnace is raised in temperature by utilizing the heat of the exhaust gases. Air pre-heater are classified into the following two categories.

- Recuperative Air heater
- Regenerative Air heater

J) ECONOMISER:- The economiser is a device, which serves to recover some of the heat being carried by exhaust flue gasses. The heat thus recovered is utilized in raised temperature in feed water being supplied to the boiler. If the water at raised and thus there is a saving in the consumption of fuel.

The economiser unit is installed in the path of the flue gasses between the boiler and the chimney.

K) STEAM SUPER HEATER:- The steam generated by a simple boiler is generally wet or at the most dry saturated. Steam super heater is a surface heat exchanger in which the wet steam is first dried at the same temperature and pressure and then raised to temperature above the saturation temperature at constant pressure. Heat of flue gasses utilized in super heating the steam and as the super heater is placed in the path of the flue gasses.

Since superheating result in the increased efficiency and economy of the steam plant.

L) FEED WATER EQUIPMENT:- The pressure inside a steaming boiler is high and so the feed water has to be raised in pressure before its entry can be affected in the boiler. Feed pump is a device which raised the pressure of water and forces it into the boiler.

VIVA-QUESTIONS :-

- What is the main pre-requirement for boilers ?
- How many types of water tube boilers ?
- How many types of fire tube boilers ?
- How many types of mountings in boiler ?
- What is the functions of mountings ?
- How many types of accessories in boiler ?
- What is the functions of accessories ?
- Why use super heater & air-pre-heater ?

EXPERIMENT NO. -3

AIM:- To study the two stroke & four stroke diesel engine.

APPARATUS USED:- Model of two stroke & four stroke diesel engine.

THEORY/INTRODUCTION:- Any type of engine or m/c which drives heat energy from the combustion of fuel or any other source and converts this energy into mechanical work is termed as a heat engine.

Heat engines may be classified into two main classes as follows:-

1. Internal combustion engine
2. External combustion engine

MAIN PARTS OF THE DIESEL ENGINE:

1. CYLINDER & CYLINDER HEAD
2. PISTON
3. PISTON RINGS
4. GUDGEON PIN
5. CONNECTING ROD
6. CRANK SHAFT
7. CRANK
8. ENGINE BEARING
9. CRANK CASE
10. FLY WHEEL
11. GOVERNOR
12. VALVES
13. FUEL PUMP & INJECTOR UNIT
14. CAM & CAM SHAFT

WORKING PROCESS OF FOUR STROKE DIESEL ENGINES

The various stroke of a four stroke diesel cycle engine are given below:-

A. SUCTION STROKE :- During this stroke the piston moves from TDC to BDC, the inlet valve open and proportionate air is sucked in the engine cylinder. In fig. shown by line 5-1.

B. COMPRESSION STROKE :- In this stroke, the piston moves (1-2) towards TDC and compressors the enclosed fuel air drawn in the engine cylinder during suction. Both the inlet and exhaust valves remain closed during the stroke.

C. EXPANSION STROKE :- When the fuel is ignited by the spark plug the hot gases are produced which drive or through the piston from T.D.C to B.D.C and thus the work is obtained in this stroke. A injector which inject and & combustion takes place at constant pressure (2-3). Both the valves remain closed during the start of this stroke but when the piston just reaches the B.D.C the exhaust valve opens.

D. EXHAUST STROKE :- This is the last stroke of the cycle. Here the gases from which the work has been collected become useless after the completion of the expansion stroke and are made to escape through exhaust valve to the atmosphere. This removed of gas is accomplished during this stroke. The piston moves from B.D.C to T.D.C and the exhaust gases are driven out of the engine cylinder. This is also called scavenging. This is represented by the line (1-5).

WORKING PROCESS OF TWO STROKE DIESEL ENGINE:

In two stroke engine, the working cycle is completed into two stroke of the piston or one revolution of crankshaft. In two stroke engine the intake and compression processes are completed during the inward stroke and Expansion & exhaust process during the outward stroke.

In figure shows a two stroke diesel engine the cylinder L is connected to a closed crank chamber . during the upward stroke of the piston M, the gases in L are compressed and

at the same time fresh air enters the crank chamber through the valve V. when the piston moves down wards, V closes and the air in the crank chamber is compressed (in fig.)

- (i) The piston is moving upwards & is compressing air which has previously been supplied to L. Injector inject and Ignition takes place at the end of the stroke. The piston then travels downwards due to expansion of the gases.
- (ii) And near the end of this stroke the piston uncovers the exhaust port (E.P) and the burnt exhaust gases escape through this port.
- (iii) The transfer port (T.P) then is uncovered immediately and the compressed air from the crank chamber flows into the cylinder and is deflected upwards by the hump provided on the head of the piston. It may be noted that the incoming air helps the removal of gases from the engine cylinder. The piston then again starts moving from B.D.C to T.D.C and the charge gets compressed when E.P and T.P are covered by the piston, thus the cycle is repeated.

APPLICATIONS:-

- I.C. engine are used in all road vehicles i.e. automobiles trucks, tractors etc.
- I.C. engine are widely used in rail road, aviation & marine.
- I.C. engine are extensively used in lawn movers boats, concretes mining equipments etc.
- Petrol engine are used in light motor vehicles.

VIVA-QUESTIONS:-

- What is scavenging?
- Why the piston of a two stroke engine is made deflector type?
- What is the ratio between speed of crankshaft to the speed of a camshaft?
- How is an I.C. engine started?
- What is supercharging ? how and where is it done?

EXPERIMENT No.-4

AIM:- To study the two stroke & four stroke petrol engine.

APPARATUS USED:- Model of two stroke & four stroke petrol engine.

THEORY/INTRODUCTION:- Any type of engine or m/c which drives heat energy from the combustion of fuel or any other source and converts this energy into mechanical work is termed as a heat engine.

Heat engines may be classified into two main classes as follows:-

1. Internal combustion engine
2. External combustion engine

MAIN PARTS OF THE PETROL ENGINE:

1. CYLINDER & CYLINDER HEAD
2. PISTON
3. PISTON RINGS
4. GUDGEON PIN
5. CONNECTING ROD
6. CRANK SHAFT
7. CRANK
8. ENGINE BEARING
9. CRANK CASE
10. FLY WHEEL
11. GOVERNOR
12. VALVES
13. SPARK PLUG
14. CARBURATOR
15. CAM & CAM SHAFT

WORKING PROCESS OF OTTO FOUR STROKE ENGINES

The various stroke of a four stroke (otto) cycle engine are given below:-

A. SUCTION STROKE :- During this stroke the piston moves from TDC to BDC, the inlet valve open and proportionate fuel-air mixture is sucked in the engine cylinder. In fig. shown by line 5-1.

B. COMPRESSION STROKE :- In this stroke, the piston moves (1-2) towards TDC and compressors the enclosed fuel air mixture drawn in the engine cylinder during suction. Both the inlet and exhaust valves remain closed during the stroke.

C. EXPANSION STROKE :- When the mixture is ignited by the spark plug the hot gases are produced which drive or through the piston from T.D.C to B.D.C and thus the work is obtained in this stroke. A spark plug which ignites the mixture & combustion takes place at constant volume (2-3). Both the valves remain closed during the start of this stroke but when the piston just reaches the B.D.C the exhaust valve opens.

D. EXHAUST STROKE :- This is the last stroke of the cycle. Here the gases from which the work has been collected become useless after the completion of the expansion stroke and are made to escape through exhaust valve to the atmosphere. This removed of gas is accomplished during this stroke. The piston moves from B.D.C to T.D.C and the exhaust gases are driven out of the engine cylinder. This is also called scavenging. This is represented by the line (1-5).

WORKING PROCESS OF TWO STROKE PETROL ENGINE:

In two stroke engine, the working cycle is completed into two stroke of the piston or one revolution of crankshaft. In two stroke engine the intake and compression processes are completed during the inward stroke and Expansion & exhaust process during the outward stroke.

In figure shows a two stroke petrol engine the cylinder L is connected to a closed crank chamber . during the upward stroke of the piston M, the gases in L are compressed and at the same time fresh air and fuel (petrol) mixture enters the crank chamber through the valve V. when the piston moves down wards, V closes and the mixture in the crank chamber is compressed (in fig.)

1. The piston is moving upwards & is compressing an explosive charge which has previously been supplied to L. Ignition takes place at the end of the stroke. The piston then travels downwards due to expansion of the gases.
2. And near the end of this stroke the piston uncovers the exhaust port (E.P) and the burnt exhaust gases escape through this port.
3. The transfer port (T.P) then is uncovered immediately and the compressed charge from the crank chamber flows into the cylinder and is deflected upwards by the hump provided on the head of the piston. It may be noted that the incoming air petrol mixture helps the removal of gases from the engine cylinder, if in case these exhaust gases do not leave the cylinder the fresh charge gets diluted and efficiency of the engine will decrease. The piston then again starts moving from B.D.C to T.D.C and the charge gets compressed when E.P and T.P are covered by the piston, thus the cycle is repeated.

APPLICATIONS:-

- (i) I.C. engine are used in all road vehicles i.e. automobiles trucks, tractors etc.
- (ii) I.C. engine are widely used in rail road, aviation & marine.
- (iii) I.C. engine are extensively used in lawn movers boats, concretes mining equipments etc.
- (iv) Petrol engine are used in light motor vehicles.

VIVA-QUESTIONS:-

- (i) What is scavenging?
- (ii) Why the piston of a two stroke engine is made deflector type?
- (iii) What is the ratio between speed of crankshaft to the speed of a camshaft?
- (iv) How is an I.C. engine started?
- (v) What is supercharging ? how and where is it done?

EXPERIMENT NO.:- 5

AIM:- To determine Mechanical Advantage, V.R. and Efficiency of worm and worm gear of single, double and triple start.

APPARATUS USED:- Worm and Worm wheel, rope and weight.

CONSTRUCTION AND THEORY:-It consists of a square threaded screw, S(known as worm) and a toothed wheel(known as worm wheel)geared with each other, as shown in the figure A. Wheel A is attached to the worm, over which passes a rope. Some times a handle is also fixed to the worm (instead of the wheel). A load drum is securely mounted on the worm wheel.

Let, l = Radius of the effort wheel(length of the

handle) R = Radius of the load drum

W = Load lifted

P = Effort applied to lift the load, and

T = No. of teeth on the worm wheel

We know that distance moved by the effort in one revolution of the wheel = $2\pi l$

- If worm is single threaded, then the load drum will move through = $1/T$ revolution and distance , through which the load will move = $2\pi r/T$

$$\begin{aligned} \text{V.R.} &= \text{Distance moved by effort/Distance moved by load} \\ &= 1.T/r \end{aligned}$$

$$\text{now M.A.} = W/P$$

$$\text{And efficiency M.A./V.R.}$$

- If the worm is double threaded i.e. for one revolution of wheel A, the screw pushes the worm wheel through two teeth, then

$$\text{V.R.} = 1T/2r$$

- If the worm is triple threaded (for one revolution)

$$\text{V.R.} = 1T/3r$$

PROCEDURE :-

1. Attached one end of the string or rope passing around the pulley (effort wheel or handle) which is fixed and second end to the lock over which weights are placed for applying effort.
2. attached one of the string or rope around the load drum and second end to the hook over which weights are placed which are to be lifted.
3. put the weights in the effort side and go on adding the weights till the load or weight is just on point of moving up worm and worm wheel.
4. Note the effort applied also (which is a weight)
5. Note down the distance moved by effort and load sides.
6. repeat the experiment with different load or weights and different distances of 'P' & 'W'.

OBSERVATION :-

S.No.	Load (W) in Nt.	Effort (P) in Nt.	Distance moved by effort	Distance moved by load	V.R.	M.A.	Efficiency

CALCULATION :-

$$\text{M.A.} = W/P$$

$$\text{V.R.} =$$

$$\text{Efficiency} = \text{M.A./V.R}$$

PRECAUTIONS :-

1. Weight should be kept gently.
2. The pulley must be parallel to each other.
3. The string or rope should be in extendable and right weight.
4. The pulley should be lubricated to decrease friction.
5. The load or effort should not touch anything.

RESULT :-

- $\text{M.A.} = W/P$
- $\text{V.R.} =$
- $\text{Efficiency} = \text{M.A./V.R}$

CONCLUSION :-**VIVA-QUESTIONS :-**

1. What is mean by worm & worm wheel ?
2. How much distance moved by the load ? if the worm is single, double& triple threaded.
3. How will define to V.R. ?
4. How M.A is related to velocity ratio for an ideal m/c ?

EXPERIMENT No.-6

AIM :- To determine M.A., V.R. and efficiency of single and double purchase winch crab.

APPARATUS :- Single and double purchase winch crab, measuring instruments, weights, string and hanger.

THEORY :- Winch crab is a kind of lifting m/c in which velocity ratio obtained by employing spur gears. This m/c. is basically used on boats ships to raise starboard or tightening rope and on bridges and dam to operate lockage. These are classified as:

1. Single purchase Winch crab.
2. Double purchase Winch Crab

Single Purchase Winch Crab :- It consists of two parallel spindles, upper one called effort spindle and lower one is called as load spindle. One effort spindle a small touched wheel pinion is mounted in such a way that pinion and a lever is attached to apply the effort. On load spindle, a large toothed wheel known as spur wheel is mounted in such a way that pinion meshes with it. The load spindle also carries a cylinder of dia 'd'. Both the spindles are suitably mounted on a rigid frame. A rope is wound round the cylinder while load is attached on the other end,

Let,

P = Effort applied

W = load lifted

T_p = No. of teeth on pinion

T_w = No. of teeth on wheel

l = length of the lever arm

d = diameter of the cylinder

Suppose, lever arm is rotated by one revolution

Therefore distance moved by effort = $2\pi l$

The pinion will also make one revolution and the spur wheel makes T_p/T_w rev.

Distance moved by load in T_p/T_w revolutions of spur wheel = $\pi d * T_p/T_w$

Velocity ratio = Distance moved by effort / Distance moved load.

$$= \frac{2\pi l}{\pi d * T_w / T_p}$$

$$= \frac{2l}{d} * \frac{T_w}{T_p}$$

$$T_p \text{ M. A.} = W / P$$

Double Purchase Winch Crab :-

In this case to obtain velocity ratio compound gear train is used, because intermediately gears are compound wheel mounted on the same shaft. Other arrangements are similar to that of single purchase winch crab.

Let, T₁ & T₃ = No. of teeth on pinion.

T₂ & T₄ = No. of teeth on the spur wheels.

l = Length of the lever d

= Dof the load spindle

W = Load lifted,

P = Effort applied to lift the load, at the end of the handle.

CALCULATION :-

$$M.A. = W/P$$

$$V.R. =$$

$$\text{Efficiency} = M.A./V.R$$

PRECAUTIONS :-

1. Lubricate all the moving parts to decrease friction.
2. The string on the pulley and drum should not overlap.
3. weight should be gently put on the effort pan.
4. Add the weight of pan in the total effort.
5. There should not be any knot in the strings.

RESULT :-**CONCLUSION :-****VIVA-QUESTIONS :-**

- What are the winch crab ?
- What is differences in single & double winch crabs ?
- What is effect of friction in efficiency of m/c.
- How many gears is used in single winch crab ?
- How M.A. is related to V.R. for an ideal m/c ?

EXPERIMENT NO.:- 7

AIM :- To draw shear force and bending moment diagram for a simply supported beam under point and distributed loads.

APPARATUS USED :- Apparatus of simply supported beam.

THEORY :-

BEAM :- It is a structural member on which the load act perpendicular to axis. It is that whenever a horizontal beam is loaded with vertical loads, sometimes it bends due to the action of the loads. The amounts by which a beam bends, depends upon the amount and types of loads, length of beam, elasticity of the beam and the type of beam. In general beams are classified as under :

1. **Cantilever beam :-** It is a beam whose one end is fixed to a rigid support and the other end is free to move.
2. **Simply supported beam :-** A beam supported or resting freely on the walls or columns at its both ends is known as simply supported beam.
3. **Rigidly fixed or built-in beam :-** A beam whose both the ends are rigidly fixed or built in walls is called a fixed beam.
4. **Continuous beam :-** A beam support on more than two supports is known as a continuous beam. It may be noted that a continuous beam may not be overhanging beam.

TYPES OF LOADING :

1. **Concentrated or point load :-** A load acting at a point on a beam is known as concentrated or a point load.
2. **Uniformly distributed load :-** A load, which is spread over a beam in such a manner that each unit length is loaded to a same extent.
3. **Uniformly varying load :-** A load, which is spread over a beam, in such a manner that its extent varies uniformly on each unit length.

SHEAR FORCE :- The shear force at the cross-section of a beam may be defined as the unbalanced vertical forces to the right or left of the section.

BENDING MOMENT :- The bending moment at the cross-section of a beam may be defined as the algebraic sum of the moment of forces, to the section.

IMPORTANT POINTS :-

1. If loading is uniformly distributed load then shear force diagram will be a curve of first degree and B.M. diagram will be a curve of second degree.
2. If the loading is point load then its corresponding S.F. diagram would be a curve of zero degree and the B.M. diagram would be a curve of first degree.
3. If the loading is uniformly varying load its S.F. diagram would be curve of second degree and BMD will be of third degree.
4. Bending moment is maximum where shear force is zero.
5. In case of simply supported beam the first step is to calculate the reactions at the support, then we proceed in usual manner.
6. In case of cantilever beam there is no need of finding reaction and start from the free end of the beam.
7. Point of flexure is the where BM changes its sign.
8. B.M. at the support is zero for simply supported beam.

Example :- A simply supported beam 4m. long is subjected to two point loads of 2KN & 4KN each at a distance of 1.5m and 3m from the left end draw the S.F & B.M diagram for the beam.

RESULT :-

CONCLUSION :-

VIVA-QUESTIONS :-

- What is the point of contraflexure ?
- What are sagging & hogging moments ?
- Define a beam. What is a cantilever a fixed beam and an overhang beam ?
- Define S.F. & BM.
- When bending moment will be maximum?

EXPERIMENT NO.:- 8

AIM:- To study the simple and compound screw jack and to find out Mechanical Advantage, V.R. and Efficiency.

APPARATUS USED:- Simple and compound screw jack

THEORY :-

Screw Jack :- It is a device employed for lifting heavy loads with help of a small effort applied at its handle. The loads are usually centrally loaded upon it. Screw jacks of three types :

1. Simple screw jack
2. Compound Screw jack
3. Differential Screw jack

A simple screw jack consists of a nut, a screw square threaded and a handle fitted to the head of the screw. The nut also forms the body of the jack. The load to be lifted is placed on the head of the screw. Here the axial distance between corresponding points on two consecutive threads is known as pitch. If 'p' be the pitch of the screw and 't' is the thickness of thread, then $p = 2t$.

$$\begin{aligned} \text{V.R.} &= \text{Distance moved by the effort/Distance moved by the load} \\ &= 2\pi l / p \end{aligned}$$

$$\text{Now M.A.} = W / P$$

PROCEDURE :-

When we are moving the handle horizontal direction the screw is also moved it attached with screw and load is lifted by pitch of the screw, in one revolution of the handle.

OBSERVATION :-

For single Screw Jack :

S.No.	Load (W) in Nt.	Effort (P) in Nt.	Length of lever	Pitch of screw	V.R.	M.A.	Efficiency

COMPOUND SCREW JACK :-

It is a further improved form of differential screw jack, in which the velocity ratio is further intensified with the help of a geared screw jack, in which the screw is lifted with the help of worm and worm wheel, instead of effort at the end of a lever. Now consider a worm geared screw jack.

Let,

l = Radius of the effort

wheel p = pitch of the screw,

P = effort applied to lift the

load, W = Load lifted and

T = No. of teeth on the worm wheel.

We know that distance moved by effort in one revolution of wheel = $2\pi l$

If the worm is single threaded then the worm wheel move through $1/T$ revolution.

Therefore distance moved by the load = p/T

V.R. = $2\pi l / p/T$

M.A. = W/P

Efficiency = M.A. / V.R.

For Compound screw jack :

S.No.	Load (W) in Nt.	Effort (P) in Nt.	Distance moved by effort	Distance moved by load	V.R.	M.A.	Efficiency

CALCULATION :-

M.A. = W/P

V.R. = Distance moved by effort/Distance moved by load

Efficiency = M.A. / V.R.

PRECAUTIONS :-

1. Rope should not be overlap.
2. Carefully measure pitch of screw.
3. Effort handle move smoothly do not applied suddenly or jerking.
4. Oiling & greasing should be properly.

5. Effort arm measure very carefully.

RESULT :-

CONCLUSION :-

VIVA-QUESTIONS :-

- What is maximum efficiency of screw jack ?
- What is efficiency for non-reversible m/c ?
- If a m/c having an efficiency greater than 50% is known as m/c. reversible or non-reversible m/c.
- Who is m/c self locking m/c ?
- What is the max. M.A. of a lifting m/c ?

EXPERIMENT NO:-9

AIM : - To study the various types of dynamometers.

APPARATUS USED : - Models of dynamometer.

THEORY:- The dynamometer is a device used to measure the torque being exerted along a rotating shaft so as to determine the shaft power.

Dynamometers are generally classified into:

- 1) Absorption dynamometers (i.e. Prony brakes, hydraulic or fluid friction brakes, fan brake and eddy current dynamometers)
- 2) Transmission dynamometers (i.e. Torsion and belt dynamometers, and strain gauge dynamometer)
- 3) Driving dynamometers (i.e. Electric cradled dynamometer)

PRONY BRAKE : - The prony and the rope brakes are the two types of mechanical brakes chiefly employed for power measurement. The prony brake has two common arrangements in the block type and the band type. Block type is employed to high speed shaft and band type measures the power of low speed shaft.

BLOCK TYPE PRONY BRAKE DYNAMOMETER :- The block type prony brake consists of two blocks of wood of which embraces rather less than one half of the pulley rim. One block carries a lever arm to the end of which a pull can be applied by means of a dead weight or spring balance. A second arm projects from the block in the opposite direction and carries a counter weight to balance the brake when unloaded. When operating, friction between the blocks and the pulley tends to rotate the blocks in the direction of the rotation of the shaft. This tendency is prevented by adding weights at the extremity of the lever arm so that it remains horizontal in a position of equilibrium.

Torque, $T = W \cdot l$ in Nm Power

$P = 2\pi N \cdot T/60$ in N-m/s

$= 2\pi N \cdot W \cdot l/60 \cdot 1000$ in kW

Where, W = weights in Newton

l = Effective length of the lever arm in meter and

N = Revolutions of the crankshaft per minute.

BAND TYPE PRONY BRAKE DYNAMOMETER: - The band type prony brake consists of an adjustable steel band to which are fastened wooden block which are in contact with the engine brake-drum. The frictional grip between the band the brake drum can be adjusted by tightening or loosening the clamp. The torque is transmitted to the knife edge through the torque arm. The knife edge rests on a platform or communicates with a spring balance.

Frictional torque at the drum = $F \cdot r$

Balancing torque = $W \cdot l$

Under equilibrium conditions, $T = F \cdot r = W \cdot l$ in

Nm. Power = $2\pi N \cdot T/60$ in N-m/s

= $2\pi N \cdot W \cdot l/60 \cdot 1000$ in kW

ROPE BRAKE DYNAMOMETERS: - A rope brake dynamometers consists of one or more ropes wrapped around the fly wheel of an engine whose power is to be measured. The ropes are spaced evenly across the width of the rim by flywheel. The upward ends of the rope are connected together and attached to a spring balance, and the downward ends are kept in place by a dead weight. The rotation of flywheel produces frictional force and the rope tightens. Consequently a force is induced in the spring balance.

Effective radius of the brake $R = (D + d)/2$

Brake load or net load = $(W - S)$ in Newton

Braking torque $T = (W - S) R$ in Nm.

Braking torque = $2\pi N \cdot T/60$ in N-m/s

= $2\pi N \cdot (W - S)R/60 \cdot 1000$ in

kW $D =$ dia. Of drum

$d =$ rope dia.

$S =$ spring balance reading

FLUID FRICTION (HYDRAULIC DYNAMOMETER):- A hydraulic dynamometer uses fluid-friction rather than friction for dissipating the input energy. The unit consists essentially of two elements namely a rotating disk and a stationary casing. The rotating disk is keyed to the driving shaft of the prime-mover and it revolves inside the stationary casing. When the brake is operating, the water follows a helical path in the chamber. Vortices and eddy-

currents are set-up in the water and these tend to turn the dynamometer casing in the direction of rotation of the engine shaft. This tendency is resisted by the brake arm and balance system that measure the torque.

$$\text{Brake power} = W \cdot N / k,$$

Where W is weight as lever arm, N is speed in revolutions per minute and k is dynamometer constant.

Approximate speed limit = 10,000rpm

Usual power limit = 20,000kW

BEVIS GIBSON FLASH LIGHT TORSION DYNAMOMETER: - This torsion dynamometer is based on the fact that for a given shaft, the torque transmitted is directly proportional to the angle of twist. This twist is measured and the corresponding torque estimated the relation:

$$T = I_p \cdot C \cdot \theta / l$$

Where $I_p = \pi d^4 / 32$ = polar moment of inertia of a shaft of diameter d

θ = twist in radians over length l of the shaft

C = modulus of rigidity of shaft material

APPLICATIONS:-

- i) For torque measurement.
- ii) For power measurement.

VIVA-QUESTIONS:-

- (vi) How many types of method of shaft power measurement ?
- (vii) How many types of mechanical brakes ?
- (viii) Which type mechanical brake use for high speed and low speed shaft ?
- (ix) What is mean by effective radius of the brake drum?
- (x) Which types of bearing is same as the friction torque transmitted by a disc or plate clutch?

EXPERIMENT NO.-10

AIM:- To study the constructional features & working of Pelton, Kaplan and Francis turbine.

APPARATUS USED:- Models of Pelton turbine, Kaplan turbine and Francis turbine.

THEORY:- A hydraulic turbine uses the potential and kinetic energy of water and converts it into usable mechanical energy. The fluid energy is available in the nature or artificial high level water reservoirs which are created by constructing dams at appropriate places in the flow path of rivers. When water from the reservoir is taken to the turbine, transfer of energy takes place in the blade passages of the unit.

Mainly two types of turbine:

- 1) Impulse turbine
- 2) Reaction turbine

In addition to the concept of impulse and reaction, hydraulic turbines may be further classified into various kinds according to:

(a) Direction of water flow through runner:

1. Tangential flow (Pelton wheel)
2. Axial or parallel flow (Kaplan turbine)
3. Mixed-radial and axial (Modern Francis turbine)
4. Outward radial flow (Fourneyron turbine)
5. Inward radial flow (old Francis turbine)

(b) Available head and discharge:

1. High head turbines (above 250m)- Pelton wheel
2. Medium head turbine (60m to 250m)- Modern Francis turbine
3. Low head turbine (upto 30m.) – Propeller and Kaplan turbine

(c) Specific speed:

1. For Pelton wheel
 - (i) $N_s = 9-17$ rpm. for a slow runner
 - (ii) $N_s = 17-25$ rpm. for a normal runner
 - (iii) $N_s = 25-30$ rpm. for fast runner
 - (iv) $N_s = 40$ rpm. for a double jet

2. Francis turbine

- (i) $N_s = 50-100$ rpm. for a slow runner
- (ii) $N_s = 100-150$ rpm. for a normal runner
- (iii) $N_s = 150-250$ rpm. for a fast runner

3. Kaplan turbine

- (i) $N_s = 250-850$ rpm.

(c) Disposition of shaft:

- 1. Horizontal shaft
- 2. vertical shaft

PELTON TURBINE:- A pelton wheel is a free – jet impulse turbine named after the American engineer Lesser Pelton (1829-1908) Who contributed much to its development. It is simple, robust and the only hydraulic turbine which operates efficiently and is invariably used for heads in excess of 450m. Smooth running and good performance are other common features of this unit.

Component Parts:

- i) Penstock
- ii) Spear and nozzle
- iii) Runner with buckets
- iv) Casing Governing mechanism

FRANCIS TURBINE:- Francis turbine is an inward flow reaction turbine which was designed and developed by the American engineer James B. Francis (1815-1892). In the earlier stages of its development, Francis turbine had a purely radial flow runner; the flow passing through the runner had velocity component only in a plane normal to the axis of the runner. The modern Francis turbine is, however, a mixed flow unit in which the water enters the runner radially at its outer periphery and leaves axially at its centre.

Component Parts:

- i) Penstock
- ii) Scroll casing
- iii) Guide vanes or wicket gates

- iv) Guide wheel and governing mechanism
- v) Runner and runner blades
- vi) Draft tube

KAPLAN TURBINE: The propeller turbine is a reaction turbine which is particularly suited for low head (upto 30m) and high flow installations.i.e at barrages in rivers. The unit is like the propeller of a ship operating in reverse. The ship propeller rotates, thrusts the water away behind it and thus causes the ship to move forward. In a propeller turbine, the water flows through the propeller and sets it in motion. Water enter the turbine laterally, gets deflected by the guide vanes and the flows through the propeller. For this reason, these machines are referred to as axial flow units.

Component Parts:

- i) Scroll casing
- ii) Stay ring
- iii) Guide mechanism
- iv) Draft tube

APPLICATIONS:-

- i) In thermal power plans.
- ii) In hydro-electric power plants.

VIVA-QUESTIONS:-

- (xi) What are different types of steam nozzles used in impulse turbine? Which of these types is most common and why?
- (xii) What are the advantages of steam turbine over steam engine?
- (xiii) How many moving blades are generally employed in an actual turbine?
- (xiv) What is the main difference between a 'pure reaction turbine' and an 'impulse-reaction turbine'?
- (xv) What is the material of steam turbine blades?

EXPERIMENT No.-11

AIM :- To prepare stress-strain diagram for mild steel and cast iron specimens under tension and compression respectively on a U.T.M.

APPARATUS :- A UTM, mild steel specimen, vernier caliper/micrometer, dial gauge & graph paper.

THEORY :- Various m/c and structure components are subjected to tensile loading in numerous application. For safe design of these components, their ultimate tensile strength and ductility one to be determine before actual use. Tensile test can be conducted on UTM.

A material when subjected to a tensile load resists the applied load by developing internal resisting force. These resistances come due to atomic bonding between atoms of the material. The resisting force for unit normal cross-section area is known as stress.

The value of stress in material goes on increasing with an increase in applied tensile load, but it has a certain maximum (finite) limit too. The minimum stress, at which a material fails, is called ultimate tensile strength.

The end of elastic limit is indicated by the yield point (load). This can be seen during experiment as explained later in procedure with increase in loading beyond elastic limit original cross-section area (A_0) goes on decreasing and finally reduces to its minimum value when the specimen breaks.

ABOUT OF UTM & ITS SPECIFICATIONS :-

The tensile test is conducted on UTM. It is hydraulically operates a pump, oil in oil sump, load dial indicator and central buttons. The left has upper, middle and lower cross heads i.e; specimen grips (or jaws). Idle cross head can be moved up and down for adjustment. The pipes connecting the left and right parts are oil pipes through which the pumped oil under pressure flows on left parts to move the cross-heads.

SPECIFICATIONS :-

1. Load capacity = 0-40000 kgf.
2. Least count = 8kgf.
3. Overall dimn. =
4. Power supply = 440V

PROCEDURE :-

1. The load pointer is set at zero by adjusting the initial setting knob.
2. The dial gauge is fixed and the specimen for measuring elongation of small amounts.
3. Measuring the diameter of the test piece by vernier caliper at least at three places and determine the mean value also mark the gauge length.
4. Now the specimen is gripped between upper and middle cross head jaws of the m/c.
5. Set the automatic graph recording system.
6. Start the m/c and take the reading.
7. The specimen is loaded gradually and the elongation is noted until the specimen breaks.

OBSEVATION :-

- (I) Initial diameter of specimen d_1 = -----
- (II) Initial gauge length of specimen L_1 = -----
- (III) Initial cross-section area of specimen A_1 = ----
- (IV) Load of yield point F_t . = -----
- (V) Ultimate load after specimen breaking F = -----
- (VI) Final length after specimen breaking L_2 = -----
- (VII) Dia. Of specimen at breaking place d_2 = -----
- (VIII) Cross section area at breaking place A_2 = ----

CALCULATION :-

- (i) Ultimate tensile strength =
- (ii) Percentage elongation % =
- (iii) Modulus of elasticity E = -----

- (iv) Yield stress = -----
(v) % reduction in area = -----

PRECAUTIONS :-

1. The specimen should be prepared in proper dimensions.
2. The specimen should be properly to get between the jaws.
3. Take reading carefully.
4. After breaking specimen stop to m/c.

RESULT :-

CONCLUSION :-

VIVA-QUESTIONS :-

- Which steel have you tested ? what is its carbon content ?
- What general information are obtained from tensile test regarding the properties of a material ?
- Which stress have you calculated : nominal stress or true stress ?
- What kind of fracture has occurred in the tensile specimen and why ?
- Which is the most ductile metal ? How much is its elongation ?