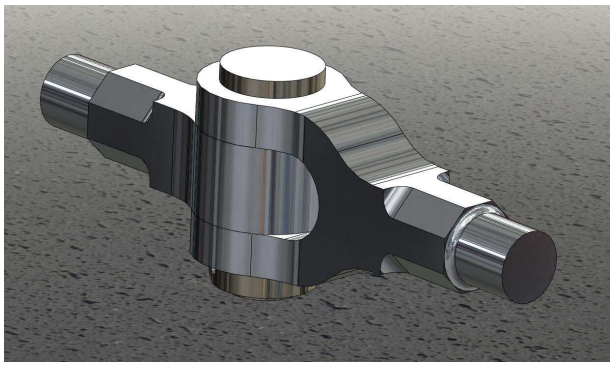
WALCHAND INSTITUTE OF TECNOLOGY, SOLAPUR



DESIGN OF KNUCKLE JOINT

ABSTRACT

Knuckle joint is used to connect two rods whose axes either coincide or intersect and lie in one plane. The knuckle joint is used to transmit axial tensile force. The construction of this joint permits limited angular movement between rods, about the axis of the pin.

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ADVANCE JAVA PROGRAMMING ON DESIGN OF KNUCKLE JOINT

CASE STUDY: DESIGN OF KNUCKLE JOINT

- **Program taking factor of safety and load as input from user**
- **Program source code:**

```
import java.util.Scanner;
class knucklejoint
{
public static void main(String args[])
{
double Syt,fs,ts,cs,ss,p,pi=3.14,D,D1,a,b,d,d1,x,y,ts1,cs1,ss1,ts2,cs2,ss2;
int material;
Scanner in=new Scanner(System.in);
System.out.println("JAVA PROGRAMMING ON DESIGN OF KNUCKLE JOINT");
System.out.println("Select suitable material for knuckle joint");
System.out.println("FOR SELECTING PLAIN CARBON STEEL PRESS 1");
System.out.println("FOR SELECTING GREY CAST IRON PRESS 2");
material=in.nextInt();
switch (material)
{
case 1:
System.out.println("FOR PLAIN CARBON STEEL VALUE OF Syt=400 N/mm2");
Syt=400;
System.out.println("Enter vaule of factor of safety=");
fs=in.nextDouble();
System.out.println();
System.out.println("The permissible stresses are as follows");
ts=Syt/fs;
cs=Syt/fs;
ss=(.5*Syt)/fs;
System.out.println();
System.out.println("The value of tensile stress is="+ts+" "+"N/mm2");
System.out.println();
System.out.println("The value of compressive stress is="+cs+" "+"N/mm2");
```

```
System.out.println();
System.out.println("The value of shear stress is="+ss+" "+"N/mm2");


System.out.println();


System.out.println("NOW THE CALCULATION OF DIMENSIONS OF KNUCKLEJOINT:");
System.out.println();
System.out.println("enter the vaule of axial tensile force in Newton=");
p=in.nextDouble();
D=Math.sqrt((4*p)/(pi*ts));
System.out.println();
System.out.println("The Diameter of rods="+D+" "+"mm");
D1=1.1*D;
System.out.println();
System.out.println("The Enlarged Diameter of rods="+D1+" "+"mm");
a=.75*D;
b=1.25*D;
System.out.println();
System.out.println("Dimension of a="+a+" "+"mm");
System.out.println();
System.out.println("Dimension of b="+b+" "+"mm");
d=Math.sqrt((2*p)/(pi*ss));
System.out.println();
System.out.println("Diameter of pin on shear stress="+d+" "+"mm");
d1=Math.cbrt((32/(pi*ts))*(p/2)*((b/4)+(a/3)));
System.out.println();
System.out.println("Diameter of pin on Bending stress="+d1+" "+"mm");
x=2*d1;
y=1.5*d1;
System.out.println();
System.out.println("Dimension of do="+x+" "+"mm");
System.out.println();
System.out.println("Dimension of d1="+y+" "+"mm");
```

```
System.out.println();

System.out.println("NOW CHECKING THE STRESSES IN EYE");
ts1=(p/(b*(x-d1)));
if(ts1<ts)
{
System.out.println("Design under tensile stress is safe");
}
else
{
System.out.println("Design under tensile stress is not safe");
}
cs1=(p/(b*d1));
if(cs1<ts)
{
System.out.println("Design under compressive stress is safe");
}
else
{
System.out.println("Design under compressive stress is not safe");
}
ss1=(p/(b*(x-d1)));
if(ss1<ss)
{
System.out.println("Design under shear stress is safe");
}
else
{
System.out.println("Design under shear stress is not safe");
}

System.out.println();
System.out.println("NOW CHECKING THE STRESSES IN FORK");
ts2=(p/(a*2*(x-d1)));
```

```
if(ts2<ts)
{
System.out.println("Design under tensile stress is safe");
}
else
{
System.out.println("Design under tensile stress is not safe");
}
cs2=(p/(2*a*d1));
if(cs2<ts)
{
System.out.println("Design under compressive stress is safe");
}
else
{
System.out.println("Design under compressive stress is not safe");
}
ss2=(p/(2*a*(x-d1)));
if(ss2<ss)
{
System.out.println("Design under shear stress is safe");
}
else
{
System.out.println("Design under shear stress is not safe");
}
System.out.println();
System.out.println("Conclusion:");
System.out.println("1.As  yield strength of plain carbon steel is greater than cast iron, so plain carbon steel is suitable for the design of knuckle joint.");
System.out.println("2.With change in load to be sustained by the knucklejoint,  the dimensions of eye, fork and pin also changes.");
break;
case 2:
System.out.println("FOR GREY CAST IRON VALUE OF Syt=200 N/mm2");
```

```
Syt=200;
System.out.println("Enter vaule of factor of safety=");
fs=in.nextDouble();
System.out.println();
System.out.println("The permissible stresses are as follows");
ts=Syt/fs;
cs=Syt/fs;
ss=(.5*Syt)/fs;
System.out.println();
System.out.println("The value of tensile stress is="+ts+" "+"N/mm2");
System.out.println("The value of compressive stress is="+cs+" "+"N/mm2");
System.out.println("The value of shear stress is="+ss+" "+"N/mm2");

System.out.println();

System.out.println("Now the calculation of dimensions of knuckle joint:");
System.out.println();
System.out.println("enter the vaule of axial tensile force in Newton=");
p=in.nextDouble();
D=Math.sqrt((4*p)/(pi*ts));
System.out.println("The Diameter of rods="+D+" "+"mm");
D1=1.1*D;
System.out.println();
System.out.println("The Enlarged Diameter of rods="+D1+" "+"mm");
a=.75*D;
b=1.25*D;
System.out.println();
System.out.println("Dimension of a="+a+" "+"mm");
System.out.println();
System.out.println("Dimension of b="+b+" "+"mm");
d=Math.sqrt((2*p)/(pi*ss));
System.out.println();
System.out.println("Diameter of pin on shear stress="+d+" "+"mm");
d1=Math.cbrt((32/(pi*ts))*(p/2)*((b/4)+(a/3)));
```

```
System.out.println();
System.out.println("Diameter of pin on Bending stress="+d1+" "+"mm");
x=2*d1;
y=1.5*d1;
System.out.println();
System.out.println("Dimension of do="+x+" "+"mm");
System.out.println();
System.out.println("Dimension of d1="+y+" "+"mm");

System.out.println();

System.out.println("NOW CHECKING THE STRESSES IN EYE");
ts1=(p/(b*(x-d1)));
if(ts1<ts)
{
System.out.println("Design under tensile stress is safe");
}
else
{
System.out.println("Design under tensile stress is not safe");
}
cs1=(p/(b*d1));
if(cs1<ts)
{
System.out.println("Design under compressive stress is safe");
}
else
{
System.out.println("Design under compressive stress is not safe");
}
ss1=(p/(b*(x-d1)));
if(ss1<ss)
{
System.out.println("Design under shear stress is safe");
```

```
}
else
{
System.out.println("Design under shear stress is not safe");
}

System.out.println();

System.out.println("NOW CHECKING THE STRESSES IN FORK");
ts2=(p/(a*2*(x-d1)));
if(ts2<ts)
{
System.out.println("Design under tensile stress is safe");
}
else
{
System.out.println("Design under tensile stress is not safe");
}
cs2=(p/(2*a*d1));
if(cs2<ts)
{
System.out.println("Design under compressive stress is safe");
}
else
{
System.out.println("Design under compressive stress is not safe");
}
ss2=(p/(2*a*(x-d1)));
if(ss2<ss)
{
System.out.println("Design under shear stress is safe");
}
else
{
```

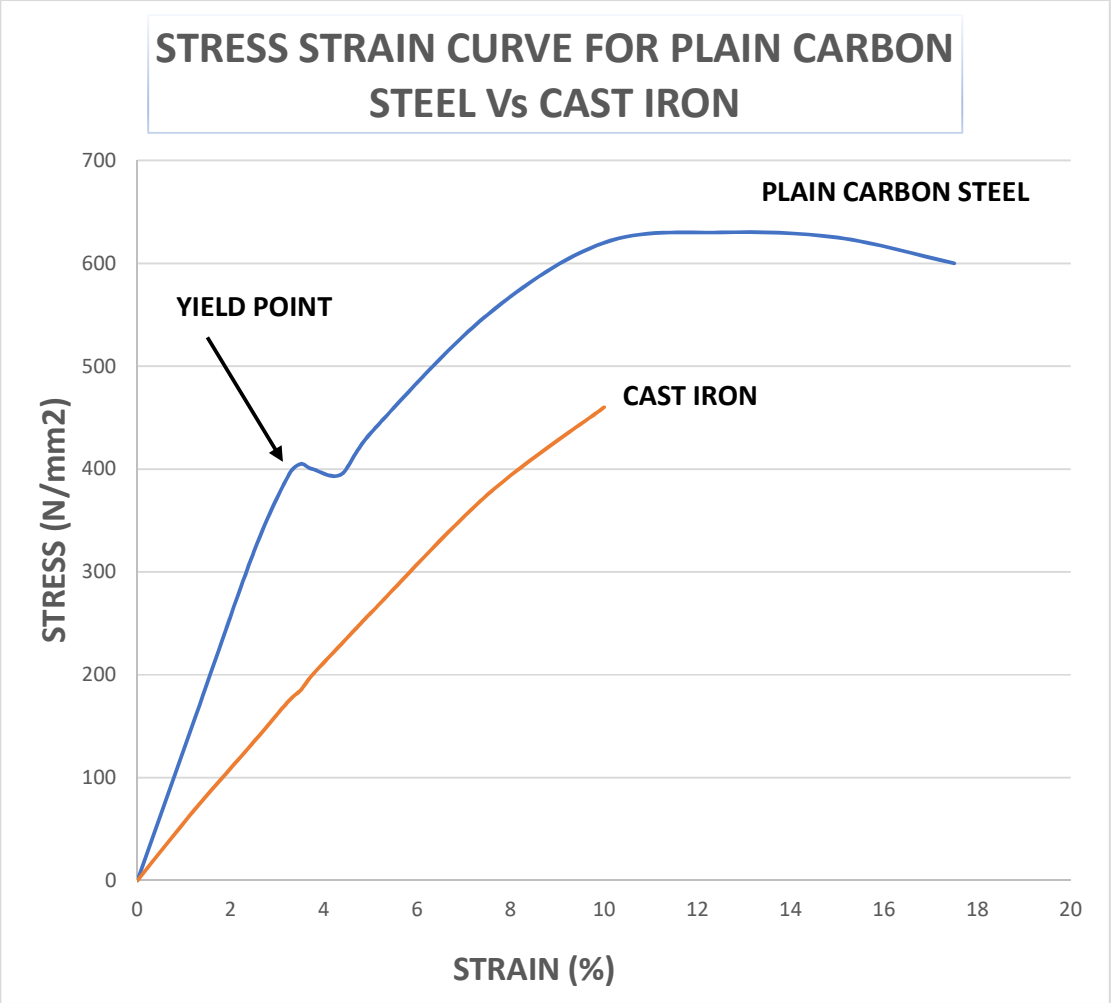
```
System.out.println("Design under shear stress is not safe");

}

System.out.println();

System.out.println("Conclusion:");

System.out.println("1.As  yield strength of plain carbon steel is greater than cast iron, so plain carbon steel is suitable for the design of knuckle joint.");

System.out.println("2.With change in load to be sustained by the knucklejoint,  the dimensions of eye, fork and pin also changes.");

break;

}}}
```

- **Two outputs of program :**

```
JAVA PROGRAMMING ON DESIGN OF KNUCKLE JOINT
Select suitable material for knuckle joint
FOR SELECTING PLAIN CARBON STEEL PRESS 1
FOR SELECTING GREY CAST IRON PRESS 2
1
FOR PLAIN CARBON STEEL VALUE OF Syt=400 N/mm2
Enter vaule of factor of safety=
4

The permissible stresses are as follows

The value of tensile stress is=100.0 N/mm2

The value of compressive stress is=100.0 N/mm2

The value of shear stress is=50.0 N/mm2

NOW THE CALCULATION OF DIMENSIONS OF KNUCKLEJOINT:

enter the vaule of axial tensile force in Newton=
50000

The Diameter of rods=25.23772325625344 mm

The Enlarged Diameter of rods=27.761495581878783 mm

Dimension of a=18.928292442190077 mm

Dimension of b=31.5471540703168 mm

Diameter of pin on shear stress=25.23772325625344 mm

Diameter of pin on Bending stress=33.070773016625964 mm

Dimension of do=66.14154603325193 mm

Dimension of d1=49.606159524938946 mm

NOW CHECKING THE STRESSES IN EYE
Design under tensile stress is safe
Design under compressive stress is safe
Design under shear stress is safe

NOW CHECKING THE STRESSES IN FORK
Design under tensile stress is safe
Design under compressive stress is safe
Design under shear stress is safe

Conclusion:
1.As  yield strength of plain carbon steel is greater than cast iron, so plain carbon steel is suitable for the design of knuckle joint.
2.With change in load to be sustained by the knucklejoint,  the dimensions of eye, fork and pin also changes.
```

```
JAVA PROGRAMMING ON DESIGN OF KNUCKLE JOINT
Select suitable material for knuckle joint
FOR SELECTING PLAIN CARBON STEEL PRESS 1
FOR SELECTING GREY CAST IRON PRESS 2
2
FOR GREY CAST IRON VALUE OF Syt=200 N/mm2
Enter vaule of factor of safety=
5

The permissible stresses are as follows

The value of tensile stress is=40.0 N/mm2
The value of compressive stress is=40.0 N/mm2
The value of shear stress is=20.0 N/mm2

Now the calculation of dimensions of knuckle joint:

enter the vaule of axial tensile force in Newton=
50000
The Diameter of rods=39.90434422338111 mm

The Enlarged Diameter of rods=43.89477864571922 mm

Dimension of a=29.92825816753583 mm

Dimension of b=49.88043027922639 mm

Diameter of pin on shear stress=39.90434422338111 mm

Diameter of pin on Bending stress=52.28948335748777 mm

Dimension of do=104.57896671497554 mm

Dimension of d1=78.43422503623165 mm

NOW CHECKING THE STRESSES IN EYE
Design under tensile stress is safe
Design under compressive stress is safe
Design under shear stress is safe

NOW CHECKING THE STRESSES IN FORK
Design under tensile stress is safe
Design under compressive stress is safe
Design under shear stress is safe

Conclusion:
1.As  yield strength of plain carbon steel is greater than cast iron, so plain carbon steel is suitable for the design of knuckle joint.
2.With change in load to be sustained by the knucklejoint,  the dimensions of eye, fork and pin also changes.
```

- **Graph:**



- **Conclusion:**
  1. **As yield strength of plain carbon steel is greater than cast iron, so plain carbon steel is suitable for the design of knuckle joint.**
  2. **With change in load to be sustained by the knuckle joint, the dimensions of eye, fork and pin also changes.**