Engine Design

Chapter 05: IC Engine Component Design-The Connecting Rod

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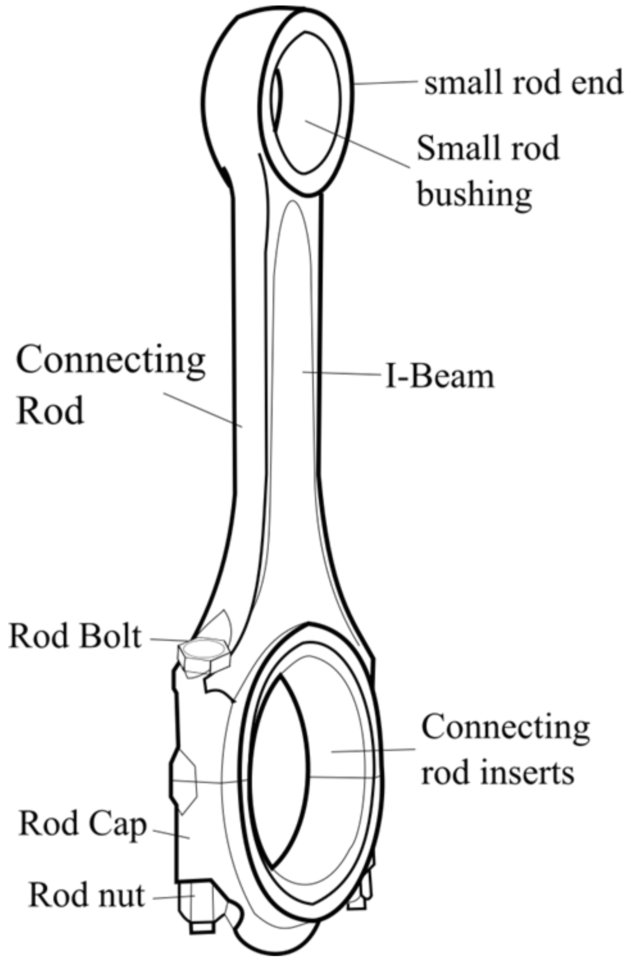
Forces acting on the Connecting Rod

- The combined effect (or joint effect) of,
- The pressure on the piston, combined with the inertia of the reciprocating parts.
- The friction of the piston rings, piston, piston rod and the cross head.
- The longitudinal component of the inertia of the rod.
- The transverse component of the inertia of the rod.
- The friction of the two end bearings.

Design of the Connecting Rod



Design of the Connecting Rod

- In designing a connecting rod the following dimensions are required to be determined.
- Dimension of cross section of connecting rod.
- Dimension of the crank pin at the big end and the piston pin at the small end.
- Size of the bolts for securing the big end cap and
- Thickness of the big end cap.

Design of the Connecting Rod

- According to **Rankines Gordon** formula,
- F about x-axis= $\frac{f_c A}{1+a(\frac{l}{k_{xx}})}$
- Let,

A= C/s area of connecting rod,

L= length of the connecting rod,

f_c= compressive yield stress,

F= buckling load,

I_{xx} and I_{yy}= Moment of inertia of the section about x-x and y-y axis respectively,

and K_{xx} and K_{yy}= Radius of gyration of the section about x-x and y-y axis respectively.

Design of the Connecting Rod

- for both ends hinged or free, l=1/data from Pg. 5, Eq. 1.29
- F about y-axis = $\frac{f_c A}{1+a(\frac{l}{k_{yy}})}$
- for both ends fixed, $l = \frac{l}{2}$ data from Pg. 5, Eq. 1.29
- In order to have a connecting rod equally strong in buckling about both the axes, the buckling loads must be equal,
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Ie. $\frac{f_c A}{1+a(\frac{l}{k_{xx}})^2} = \frac{f_c A}{1+a(\frac{l}{2k_{yy}})^2}$

Or $(\frac{l}{k_{xx}})^2 = (\frac{l}{2K_{yy}})^2$

$\therefore\ {k_{xx}}^2 = 4{k_{yy}}^2$

Or $I_{xx} = 4I_{yy}$

Example 4-1:

- **Design a connecting rod for a semi diesel engine with the following data.**

Diameter of the piston= 88mm

Weight of the reciprocating parts= 1.6kg

Length of the connecting rod= 300mm (center to center)

Stroke= 125mm

RPM= 2200 when developing 70 HP i.e. 52.2KW

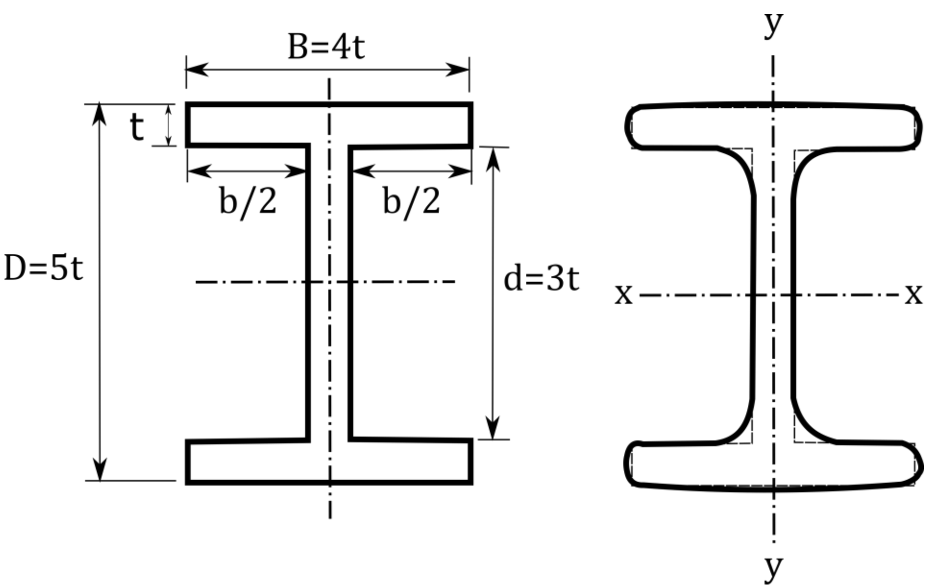
= 3000 is possible over speed.

Compression ratio= 6:8:1

Maximum combustion pressure = 34.4bar = 3.44 N/mm^2

Example 4-1: Solutions: Cross section of the connecting Rod

- In the plane of motion of the connecting rod, the ends are direction free at the crank and the gudgeon pins, and the strut is therefore, Hinged for buckling about neutral axis (x-x Axis)
- In the plane perpendicular to the motion plane (NA), (i.e. y-y axis) when buckling tends to occur about y-y axis, the strut has almost fixed ends due to the constraining effect of the bearing at crank and gudgeon pins.



Example 4-1: Solutions: Cross section of the connecting Rod

- The connecting is therefore 4 times as strong about y-y for buckling as for, the buckling about x-x due to constraining effect of the fixed ends.
  - i.e. $4\ I_{yy} = I_{xx}$
- The result is a convincing evidence of the suitability of I section.
- It can be noticed that, a circular section connecting rod, is un-necessarily strong for buckling about the y-y axis.
- The proportions given in the figure are assumed for the section as representing a typical connecting rod.

Example 4-1: Solutions:
Cross section of the connecting Rod

- Moment of inertia of the I cross section about x-x is given by,
- $I_{xx} = \frac{1}{12} BD^3 - bd^3 = \frac{1}{12}\ 4t\ 5t^3 - 3t\ 3t^3 = 34.91t^4$
- Moment of inertia of I cross section about yy is given by,
- $I_{yy} = \frac{1}{12} bD^3 - Bd^3 = \frac{1}{12}\ 2t\ 4t^3 - 3t\ t^3 = 10.91t^4$

Example 4-1: Solutions: Cross section of the connecting Rod

- Area, $A = (4t^2 + 4t^2) + 3t^2 = 11t^2$
- $I_{xx} = \frac{1}{12}BD^3 - bd^3$

$= \frac{1}{12}4t \text{ x } 5t^3 - 3t \text{ x } 3t^3$

$= 10.91\, t^4$

$\therefore \ \frac{I_{xx}}{I_{yy}} = 3.2\ approx.$

- So, in the case of this section (assumed section) proportions shown above will be satisfactory.

- Area of cross section (a)

$$A = (5t \ \text{x} \ 4t) - (3t \ \text{x} \ 3t) = \ 11\,t^2$$

- Radius of gyration K_{xx} (K) is given by,

$$K = \sqrt{\frac{I}{A}} = \sqrt{\frac{34.91^4}{11t^2}} = 1.78\ t$$

- Stroke length $= \ L = 125\ mm$

$$\therefore \text{crank radius r} = \frac{\text{stroke of piston}}{2} = \frac{\text{L}}{2} = \frac{125}{2} = 62.5\ mm$$

$$n^1 = \frac{l}{r} = \frac{\text{length of connecting rod}}{\text{crank radius}} = \frac{300}{62.5} = 4.8$$