"Design and Analysis of Rottame Kikai"

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Abstract:

Rottame kikai (crushing machine) is used to crush the cast iron pipes for storage and reused in cupola furnace to manufacture a new product. Same types of machines are available in market but cannot be for specific to crush or break cast iron pipes. Basically we design this machine to fulfill the company requirement. The crushing machine is used to crush or break cast iron pipes as well as scrap material which is used for rework. Hydraulic crushing machine finds usage to compress different types of scraps into a single piece using hydraulic power.

KeyWords: Cast Iron Pipes, Crushing, Kikai, Rottame.

Introduction:

Rottame kikai (crushing machine) is used to crush the cast iron pipes for storage and reused in cupola furnace to manufacture a new product. Same types of machines are available in market but cannot be for specific to crush or break cast iron pipes. Basically we design this machine to fulfill the company requirement. The crushing machine is used to crush or break cast iron pipes as well as scrap material which is used for rework. Hydraulic crushing machine finds usage to compress different types of scraps into a single piece using hydraulic power.

Need of the Topic:

In Kapilansh Dhatu Udyog Pvt. Ltd. (KLDUPL) there are a lot of Rejected pipes which are collected on some sections like production and in Earthing Department. Those rejected cast iron pipes are crushed by the workers/Labors. To crush these cast iron pipes many of workers/labors are in different section. The manual work is more so to minimize that we are designing a Rottame Kikai (crusher machine).

The need of this topic is simply to minimize manual work, to minimize time and the money spend to the number of workers should be minimum.

Problem Analysis:

- In the industry workers break the Cast iron pipe manually by Hammer.
- It is more of a fatiguing process to break the pipe manually.
- Time consuming process.
- Tedious work

Fig 1: Workers Manually Breaking CI Pipes

Objectives:

- To Save the manual efforts
- To Save the time
- One Time investment.

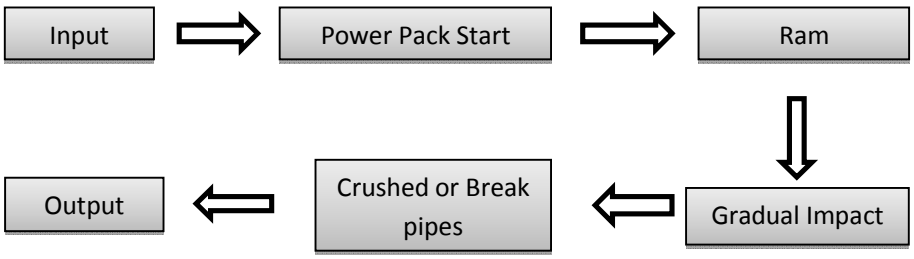

Fig 2: Working of Rottame Kikai(Crusher Machine)

Calculation and Specification:

Bed Size =1900mm X 1500mm X 16mm
Capacity: 5ton=49.05KN
Taking working Pressure (P): 115 bar

Area of Cylinder $= \frac{F}{p}$

$\frac{\pi}{4}D^2 = \frac{5000*9.8\ 1}{11.5}$

D = 73.69 mm

D = 80mm

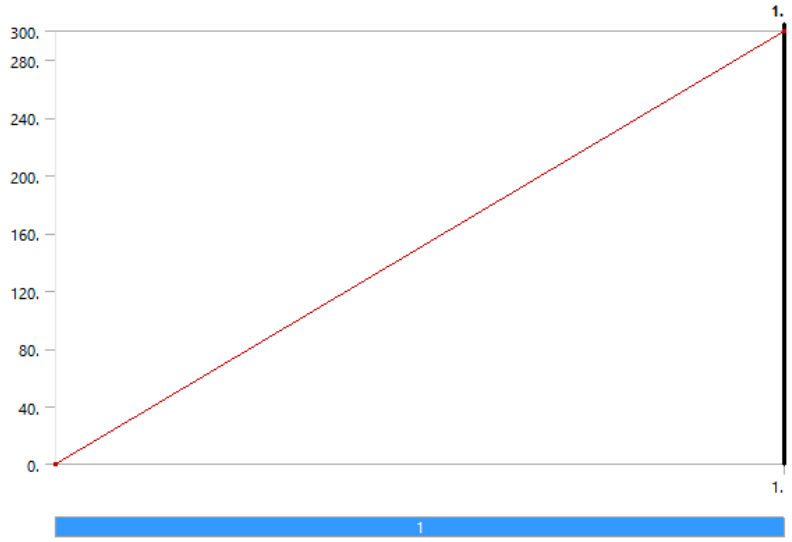

Fig 3: Model (A4) > Static Structural (A5) > Pressure

Thickness of cylinder body:

[**Brinie's Equation**]: Brinie's equation depends upon strain theory of failure. The failure occurs when the strain reaches to maximum value. According to this the wall thickness of cylinder is,

$$t^{[1]} = \frac{di}{2} * \{(\frac{s+(1-2\mu)p}{s-(1+\mu)p1})^{\frac{1}{2}} - 1\} \quad (1)$$

$$t=\frac{8\ 0}{2} * \{(\frac{165+(1-2*0.3)20}{165-(1+0.3)20})^{\frac{1}{2}} - 1\}$$

t=3.55mm

For Safety purpose considering the thickness two times, therefore t = 7.5mm

Outer Diameter

- Do = Internal Diameter+(2*Thickness) (2)
- Do = 95mm

95mm diameter Cylinder can be used.

Design of Piston Rod:

Force

F=AP (3)

$F=\frac{\pi}{4} * d^2 * p$

$F=\frac{\pi}{4} * 63^2 * 11.5$

F=57805.3 N

Taking Di/d = 1.27

80/d = 1.27

D = 62.9 mm

D= 63mm

Volume of cylinders

Bore side

Vb= $\pi/4*D^2*L$

Vb= $\pi/4*80^2*500$

Vb= $2.5*10^6$ mm^3

- **Ram Side**

Vr = $\pi/4*D^2*L$

Vr = $\pi/4*63^2*500$

Vr = $1.55*10^6$ mm^3

Time required for both stroke

- $T=\frac{V}{Fr}$ (4)
- One stroke required time (Assumed) = 30 seconds
- F =83766.66 mm^3/sec

W.K.T = $1mm^3/sec$= 0.00006 LPM

- Flow rate = 5.026 LPM
- Let Q = 5 LPM to make gear pump for operation

Time required for return stroke

$T=\frac{1.55*10^6}{\left(\frac{5.026}{0.00006}\right)}$

T = 18.5 sec

$tc = 80*(\sqrt{0.1875}*\frac{11.5}{165}$

tc = 9.14 mm

Considering tc=20 *mm*

Buckling of Piston rod

- By using

$\sigma_c = F/A\ [1+\frac{a}{n}*\left(\frac{Lc}{k}\right)^2]$ (5)

Where,

- $K=\frac{\sqrt{I}}{A}$
- Diameter of pinion = 63 mm
- $A=\pi/4*D^2$
- $A = \pi/4*63^2$
- A = 3117.2 mm^2

$I=\frac{\pi}{64}*D^4$ (6)

$I=\frac{\pi}{64}*63^4$

I = $773.27*10^6$ mm^4

$k=\frac{\sqrt{I}}{A}$ (7)

$k = \sqrt{\frac{7\ 7.37*10^6}{3117.2}}$

k = 15.75

E = Young's modulus = $207*10^3$ N/mm^2

$$\sigma_c = F/A\ [1+\frac{a}{n} * (\frac{Lc}{k})^2] \quad (8)$$

$$320 = F/372\ [1+\frac{\frac{1}{7\ 560}}{0.25} * (\frac{1200}{15.7\ 5})^2]$$

F = 292.37KN

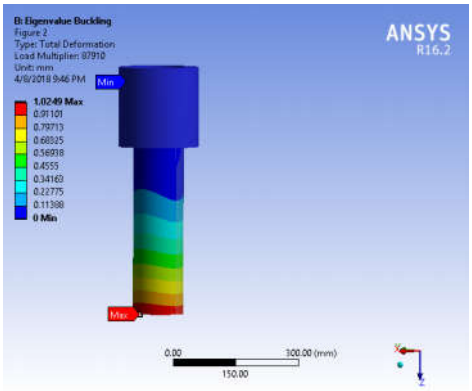

Fig. 4: Buckling of Piston Rod

As per the analysis, the critical load for buckling is 293 KN which is greater than 57.8 KN hence design is safe.

Motor Required HP

Motor Required HP

$$HP = \frac{flow\ rate(LPM)*pressure(LPM)}{442} \quad (9)$$

$$HP = \frac{5.028 * 115}{442}$$

$$\mathbf{HP = 1.307}$$

Thickness of cylinder end cover

- $F = \pi*Di*t_c*\sigma_a$ (10)
- t_c = thickness
- σ_a= Allowable tensile stress for mild steel
  =165 Mpa

F = 57805.3 N

$tc = 80*(\sqrt{0.1875} * \frac{11.5}{165}$

tc = 9.14 mm

tc = 2*9.14

=18.29 mm

tc≅ 20 mm

- **Checking buckling of piston rod**
  By Rankine formula

$$\sigma_c = F/A \left[1+\frac{a}{n} * \left(\frac{Lc}{k}\right)^2\right] \quad (11)$$

Where,

- K= Radius of gyration = $\frac{\sqrt{I}}{A}$
- σ_c= Compression stress
- dp = 63 m
- A = 3117.2 mm^2

$$I = \frac{\pi}{64} * D^4$$

$$I = \frac{\pi}{64} * 63^4$$

$I = 773.27*10^6$ mm^4

$$k = \frac{\sqrt{I}}{A}$$

$$k = \sqrt{\frac{7\ 7.27*10^6}{3117.2}}$$

k = 15.75

E = Young's modulus = $207*10^3$ N/mm^2

$$\sigma_c = F/A \left[1+\frac{a}{n} * \left(\frac{Lc}{k}\right)^2\right] \quad (12)$$

$$320 = F/372 \left[1+\frac{\frac{1}{7\ 560}}{0.25} * \left(\frac{1200}{15.7\ 3}\right)^2\right]$$

F = 292.37kN

Buckling load is 293 KN which is greater than 57.8 KN , hence design is safe.

EXPERIMENTAL RESULTS:

In result carried out comparison of theoretical and analytical calculations:

Parameters	Theoretical/Calculated	Analyses By Software
Young's Modulus N/mm^2	$207*10^3 N/mm^2$	$230*10^3$ N/mm^2
Force KN	293 KN	300 KN
Load KN	57.8 KN	75.39 KN
Stress Mpa	320 Mpa	380 Mpa

Conclusion:

Our objective to design and analysis of Rottame Kikai (Crusher Machine) are fulfilled.
In analysis of Analytical method the design is fail so the load and pressure concentration are gradually impact on a cast iron pipes and break or crushed pipes and fulfilled the company requirements. Currently method is used in industry by implementing for purpose. This method is used to break cast iron pipes and fulfilled the requirements of industry

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