

# **DESIGN OF MECHANISMS AND MACHINES**

Bearing extraction press project. Part 1

(2021-2022)

## Ball bearing extraction press

*Rolling element bearings are some of the most numerous machine components in use. They can be found in a huge number of applications from precision mechanics to wind turbine, and from agricultural equipment to space crafts.*

*Due to various reasons, which will be discussed later in the module, rolling bearings fail and have to be replaced, or simply need to be disassembled for inspection. There may be some machines available for this task, but very often, a simple, manual extraction press does the same job.*

*Figure below shows an example of a ball bearing fitted on a shaft.*



*The objective of this mini-project is to design, going through the main steps of the design process, of a manual extraction press for the bearing.*

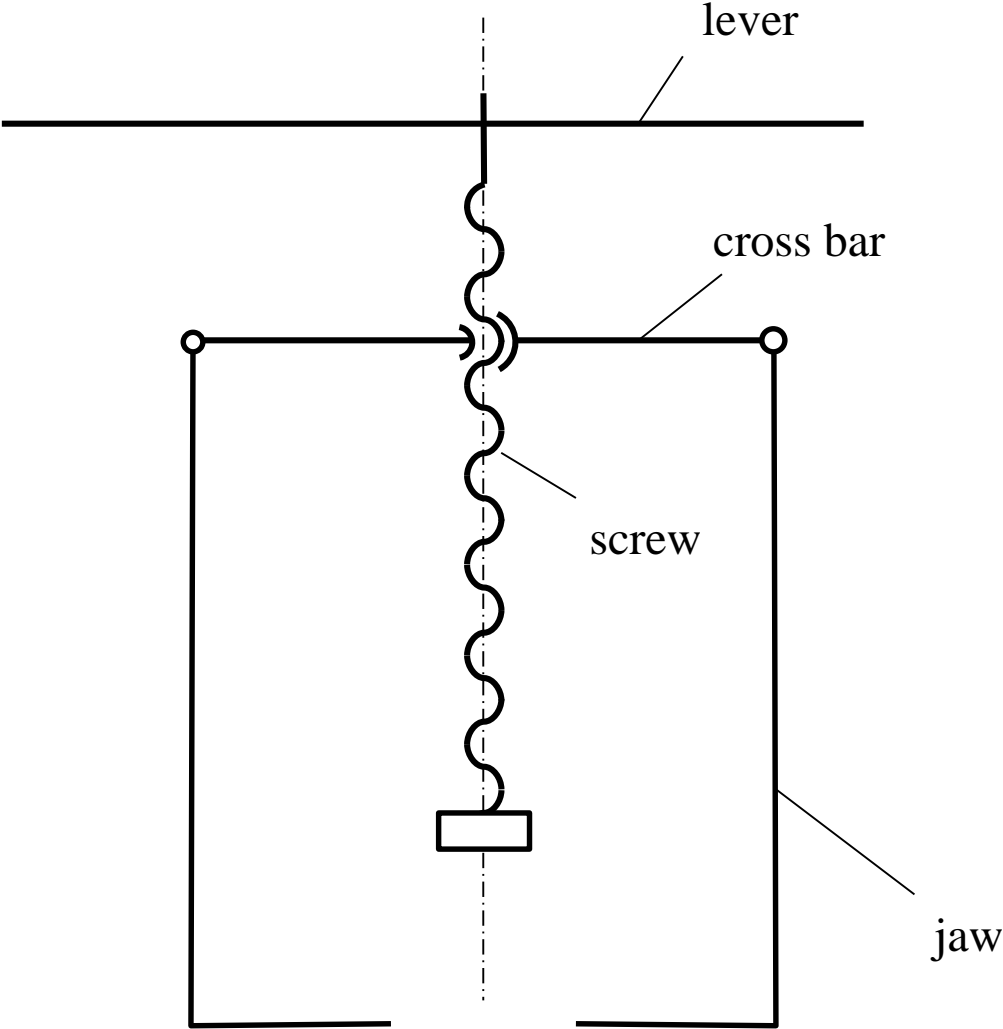
***Note:** it may be possible that the forces/torques calculated from the given data to be larger than would normally be for a manually operated device; you may want to comment on this, but continue with the exercise;*

*Individual data provided include bearing designation numbers which gives you the dimensions of the bearings. The press which you will design must fit bearings of those dimensions and smaller.*

*The tables uploaded provide dimensions of those bearings; if you need additional data regarding those bearings please search online the catalogues of main bearings manufacturers, SKF, INA-Schaeffler, NSK, Timken*

# Ball bearing extraction press;

*schematic*



# Ball bearing extraction press – exercise 1 brief

*Design a screw – nut mechanism, bearing extraction press for extracting ball bearings of class 6000 fitted to a steel shaft.*

*The press must be able to accommodate ball bearings with the bearing numbers:*

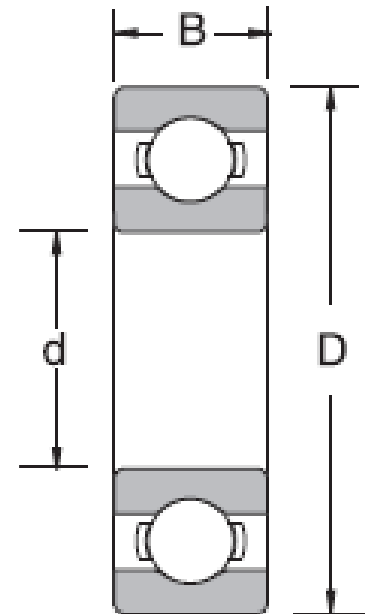
*See your individual data*

*Working conditions of the bearing:*

*Finish of fitting surface:*

*Radial load:*

*Temperature:*



<b>Bearing number</b>	<b>d</b>	<b>D</b>	<b>B</b>	<b>Dynamic load rating C<sub>r</sub> [N]</b>	<b>Static load rating C<sub>or</sub> [N]</b>
6002*	15	32	9	5850	2840
6003*	17	35	10	6000	3250
6004*	20	42	12	9850	5000
6005*	25	47	12	10600	5850
6006*	30	55	13	13900	8300
6007*	35	62	14	16800	10300
6008*	40	68	15	17600	11500
6009*	45	75	16	22000	15200
6010*	50	80	16	22900	16600
6011*	55	90	18	29700	21200
6012*	60	95	18	31000	23200
6013*	65	100	18	32000	25200
6014*	70	110	20	40000	31000
6015*	75	115	20	41500	33500
6016*	80	125	22	50000	40000
6017*	85	130	22	52000	43000

# Ball bearing extraction press – exercise 1 brief

## Part 1 – internal forces; stresses in machine components

- *Explain briefly the context of the project and write the design objectives*
- *Draw a schematic of the device (a hand drawing would also suffice, very approximate dimensions)*
- *Identify the type(s) of loading for each part and potential failure mode(s)*
- *Calculate the forces acting on each part starting with the force needed to extract the bearing*
- *Construct internal forces diagrams for one element subjected to bending, one subjected to tension/compression and one subjected to torsion (if one element is subjected to more than one type of loading you can use it to construct the diagrams for the internal forces resulted from those loadings)*
- *For one element subjected to more than one type of loading (combined loading) calculate the principal stresses at a position of your choice.*

## **Additional formulas and notes**

# Calculation of interference in rolling bearings

## *Load and interference*

*The minimum required amount of interference for inner rings mounted on solid shafts when acted on by radial loads, is found by:*

*When*

$$F_r \leq 0.3 \cdot C_{or}$$

$$\Delta_{dF} = 0.08 \sqrt{\frac{d \cdot F_r}{B}}$$

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*When*

$$F_r > 0.3 \cdot C_{or}$$

$$\Delta_{dF} = 0.02 \frac{F_r}{B}$$

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*where,*

$\Delta_{dF}$  : *Required apparent interference (for load) [ $\mu\text{m}$ ]*

$d$  : *Nominal bore diameter [mm]*

$B$  : *Inner ring width [mm]*

$F_r$  : *Radial load [N]*

$C_{or}$  : *Basic static rated load [N]*

## *Effective interference*

*The effective interference (the actual interference after fitting) is different from the apparent interference derived from the measured dimensions value. This difference is due to the roughness or slight variations of the mating surfaces, and this slight flattening of the uneven surfaces at the time of fitting is taken into consideration. The relation between the effective and apparent interference, which varies according to the finish given to the mating surfaces, is expressed by:*

$$\Delta_{eff} = \Delta_{dF} + G$$

*where,*

*$\Delta_{deff}$  : Effective interference  $\mu\text{m}$*

*$\Delta_{dF}$  : Apparent interference  $\mu\text{m}$*

*$G = 1.0 \sim 2.5 \mu\text{m}$  for ground shaft*

*$G = 5.0 \sim 7.0 \mu\text{m}$  for turned shaft*

## ***Effect of temperature***

*Interference between inner rings and steel shafts is reduced as a result of temperature increases (difference between bearing temperature and ambient temperature,  $\Delta T$ ) caused by bearing rotation. Calculation of the minimum required amount of interference in such cases is:*

$$\Delta_{eff} = 0.0015 \cdot d \cdot \Delta T$$

*where,*

*$\Delta_{deff}$  : Effective interference  $\mu m$*

*$\Delta T$  : Temperature difference*

*$G$  =nominal diameter of bearing's bore*

*from the NTN web site*

***Note:*** *Use the larger  $\Delta_{eff}$  resulted from temperature rise or calculated from the radial load*

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