Rack and Pinion

For the x axis linear movement we will be using a rack and pinion setup. The fact that this particular linear motion only serves the purpose of locating elements in the magazine means that speed and acceleration isn't a priority. Precision and accuracy is much more preferred.

The rack and pinions advantage over the belt drive is that the belt needs to be properly tensioned and is used for high speed tasks. Another possible solution is to use a linear ball screw drive, however there is a certain geometrical constraint that prevents the use of such mechanism. This will be reviewed once again during the CAD design.

To select the correct rack and pinion for the x axis linear movement, we will make a few assumptions and calculations.

Mass to be Moved	m = 5 kg
Speed	v = 1 m/s
Acceleration Time	t_b = 1 s
Acceleration Due to Gravity	g = 9.81 m/s2
Coefficient of Friction	μ = 0.15
Load Factor	K_A = 1
Life-Time Factor	f_n = 0.85
Safety Coefficient	S_B = 1.3
Linear Load Distribution Factor	$L_{KH\beta}$ = 1.5

Calculations:

$$a=\frac{v}{t_b}=\frac{1}{1}=1\,\frac{m}{s^2}$$

$$F_u=\frac{m*g*\mu+m*a}{1000}=\frac{12.3575}{1000}=0.0123575\,kN$$

The tangential force acting between our rack and pinion is quite small. We will now select an appropriate pinion and rack from a catalogue with a slightly larger feed force and compare the two values.

Assumed feed force:

rack BR(Basic Rack) C45, ind. hardened, straight tooth, module 1, (25 10 050)

pinion C45, Ind. Hardened, 20 teeth, (21 10 020), page ZB-36 F_{utab} = 1 kN

$$F_{u\,zul./per.}=\frac{F_{uTab}}{K_A*S_B*f_n*L_{KH\beta}}=\frac{1}{1.6575}=0.6\,kN$$

Condition:

$F_{u\,zul./per.}>F_u$ $\qquad$ $0.6\,kN>0.0123575\,kN$

With the above condition satisfied, we know that the rack and pinion will be sufficient for our application. However it is 50 times above our minimum value. A less industrial approach, such a plastic rack and pinion from a 3d printer may prove to be satisfactory at a much lower cost.