The Hashemite University
Faculty of Engineering
Mechanical Engineering Department

Machine Design II
Spring 2016
Instructor: Dr. Ala Hijazi

Design Project

Design of a Scissor Lift

Scissor Lifts are one of the common types of Aerial Work Platforms. They are used to provide temporary access for people or equipment to areas that are inaccessible due to their height.
You are required to design the scissor lifting mechanism according to the specifications given below. The upper platform and the lower wheeled base are provided. The scissor mechanism should move using power screw(s) installed horizontally at the lower base. Mechanical springs should be used to aid the power screw and reduce the torque required for raising the platform.

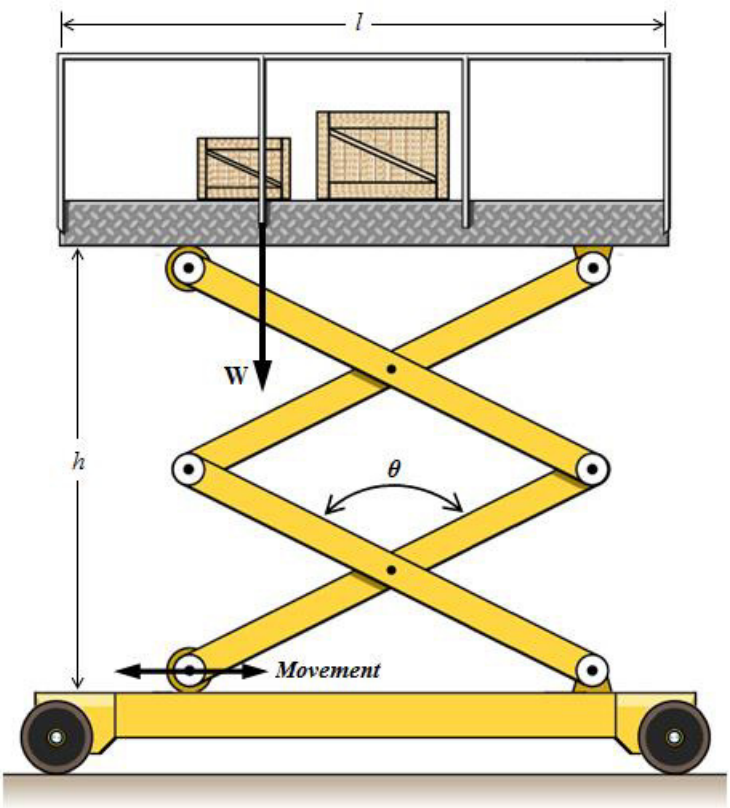
Design the scissor lifting mechanism such that it meets the following constraints:

- It will be operated using human power (assume that the operator can provide ***3 N.m*** of torque at ***90 rpm***).
- A gear set or belt drive can be used for increasing the speed or toque if needed.
- The springs are used to aid the operator in raising the platform but they should not raise it alone.
- The power screw(s) does not need to be self-locking where a one-way clutch will be used for safety purposes in order to prevent the platform from moving down due to its own weight.
- The attachment points of the scissor mechanism should be fixed to the lower base and upper platform using welding (or screws if needed).
- The scissor angle θ should be equal to ***160°*** at the starting position and it should not be less than ***70°*** when the platform is at its maximum elevation.
- For safety purposes, the center of gravity of the platform is assumed to be located at 1/3 of its length as shown in the figure.
- The depths of both the base and the platform are equal to ***0.75m***.
- The platform length (l), maximum height (h) and the platform gross weight (**W**) are specified for each group as given in the table:

Group #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
l (m)	1.8	2.4	3	1.8	2.4	3	1.8	2.4	3	1.8	2.4	3	1.8	2.4	3	1.8
h (m)	6	8	10	8	10	6	10	6	8	6	8	10	8	10	6	10
W (kg)	450	450	450	450	450	450	450	450	450	600	600	600	600	600	600	600

- You can ignore the weight of the scissor mechanism in your analysis.
- Use the following design factors:
    - n_d = 2 for the structure, pins, weldments, and fasteners.
    - n_d = 1.5 for the power screw.
    - n_d = 1.2 for the springs.

- Use standard sizes for all components:
    - Standard thickness plates (*preferred sizes Table A-17*).
    - Standard diameter pins (*preferred sizes Table A-17*).
    - Standard gauge wires for the springs (*Table A-28*).
    - Standard size fasteners (*Table 8-1*).
    - Standard size for the power screw (*Table 8-3*).



- Available materials:
    - AISI 1030 HR steel for plates, rods and structural profiles..
    - Heat treated AISI 1060 steel for the power screw (*you need to specify the heat treatment*).
    - AWS E80xx electrodes.
    - ISO class 8.8 fasteners.
    - Hard-drawn steel wires for the springs.

- Your design should meet all the requirements while maintaining a minimal cost.

You can use the flowing information for calculating the total cost of your design.

- Structural profiles and rods come in *6 m* long sections while the plates come in rectangular shapes with *1.5 x 3 m* dimensions.
- The cost of steel (plates & structural profiles) is *0.6 JD/kg* while the scrap is sold at *0.3 JD/kg*.
- The costs of other components and manufacturing operations are as follows:
    - Power screw: ***cost = (D/10) + (D×L×6×10^{-4}) JD/screw*** (*dimensions in mm*).
    - *Springs*: ***cost = D×d×N ×6×10^{-4} JD/spring*** (*dimensions in mm*).
    - Fasteners: ***cost = D×L×2×10^{-3} JD/fastener*** (*dimensions in mm*).
    - Weldments: ***cost =t×L×2×10^{-4} JD*** (*dimensions in mm*).
    - Drilling: ***cost = 0.1 JD/hole***
    - Cutting;
        - structural profiles & rods: ***cost = 0.2 JD/cut***
        - plates: ***cost = 1 JD/m***

Each group needs to submit a detailed professional report that should include:

- ***Full load and functional analyses of their design.***
- ***Design procedure, equations, table of iterations (if applicable) for each component.***
- ***Final detailed design assessment for all components.***
- ***Detailed cost calculations.***
- ***Detailed engineering drawings for all components.***