ME-1020-01 - Engg. Prog. with Matlab

Report: Final Project

By: Nicholas A. Smith

Instructor: Ha-Rok Bae

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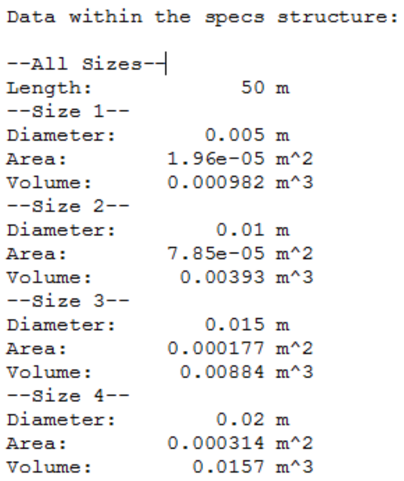
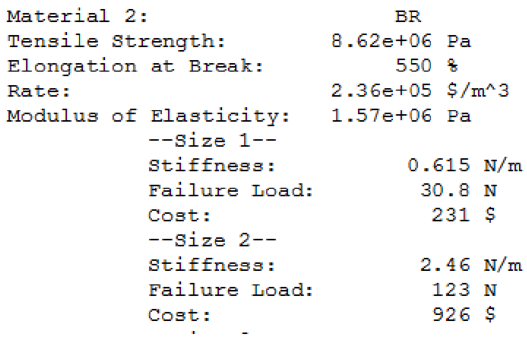
Problem Statement:

The purpose of the bungee jump final project is to use and create programing functions and problem solving techniques learned throughout the course this year. By asking for the use of extracting data from Excel with many field names; the use of structures would be a must. This allows for a flowing matrix structures to form that would be understandable and able to be used easily with mathematical problems. With structures it will also allow for a for loop to be used to output in the way that you would like, since many of the outputs are the same layout it can be made so a nice datasheet would show example the material, with its tensile strength, cost at some size…

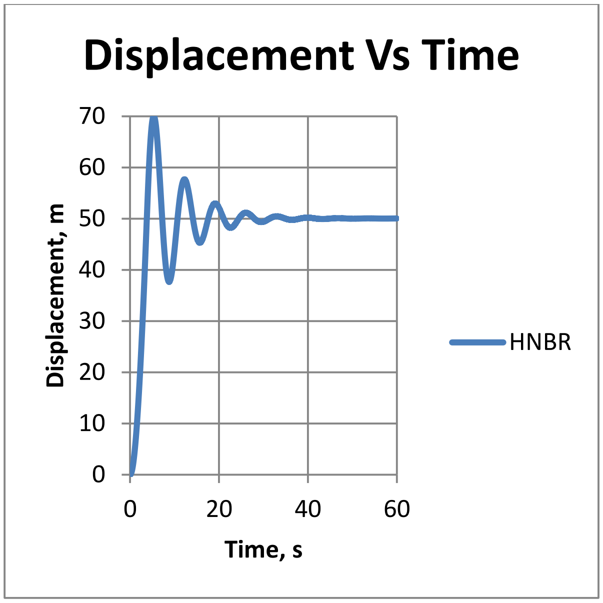


```
Data within the specs structure:

--All Sizes--
Length:             50 m
--Size 1--
Diameter:        0.005 m
Area:         1.96e-05 m^2
Volume:       0.000982 m^3
--Size 2--
Diameter:         0.01 m
Area:         7.85e-05 m^2
Volume:        0.00393 m^3
--Size 3--
Diameter:        0.015 m
Area:         0.000177 m^2
Volume:        0.00884 m^3
--Size 4--
Diameter:         0.02 m
Area:         0.000314 m^2
Volume:         0.0157 m^3
```



```
Material 2:                         BR
Tensile Strength:         8.62e+06 Pa
Elongation at Break:           550 %
Rate:                     2.36e+05 $/m^3
Modulus of Elasticity:    1.57e+06 Pa
           --Size 1--
           Stiffness:           0.615 N/m
           Failure Load:         30.8 N
           Cost:                  231 $
           --Size 2--
           Stiffness:            2.46 N/m
           Failure Load:          123 N
           Cost:                  926 $
```

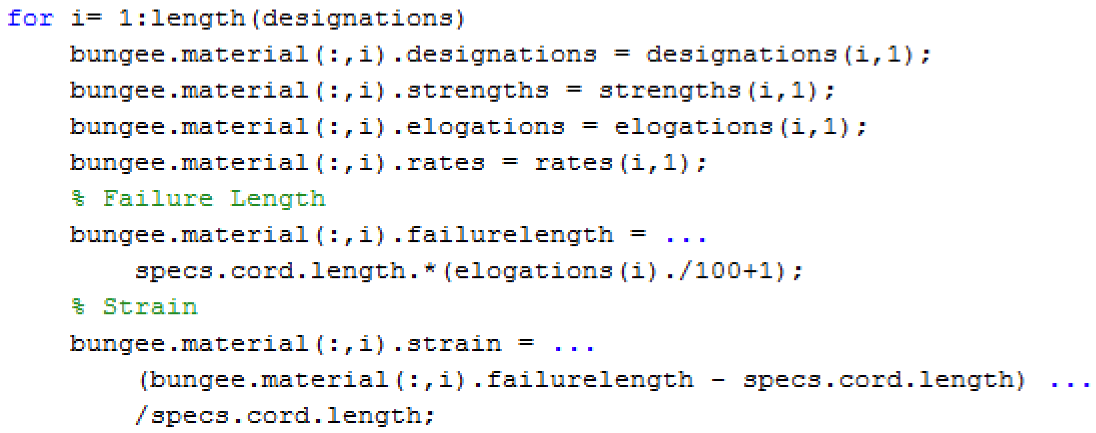


Specifications:

This program must output to a text file with the proper format shown above using \r for return rows, \n for new line, and \t for a tab over along with how many decimal should be shown and how many spaces it is able to take up. It must also produce a graph that has a y and x axes title along with a main title of “Displacement Vs. Time” as show in the graph above.

Inputs & Outputs:

It must have an input function for designations, strengths, elongations, and rates from page “Material Data”. It will also need an input function for the “Specifications” page for length of the core, diameter min, diameter max, diameter interval, and the mass min and max, and damping of the jumper. The constraints of the displacement max allowed, and the acceleration max allowed will not be used in the calculations, however it will be used for comparing values produced to find the safe list that will be output into excel.



```
for i= 1:length(designations)
    bungee.material(:,i).designations = designations(i,1);
    bungee.material(:,i).strengths = strengths(i,1);
    bungee.material(:,i).elogations = elogations(i,1);
    bungee.material(:,i).rates = rates(i,1);
    % Failure Length
    bungee.material(:,i).failurelength = ...
        specs.cord.length.*(elogations(i)./100+1);
    % Strain
    bungee.material(:,i).strain = ...
        (bungee.material(:,i).failurelength - specs.cord.length) ...
        /specs.cord.length;
```

The outputs are produced by a set of calculations as show above with a for loop the size of the amount of materials there are and creates a struck layout as started like bungee -> material - > wanted output name. There is also a set of output values that need a size designation and have another for loop the size of the incremented array of the diameter min to max and adds to the bungee.material.size -> wanted output.

Design Features

The way this program is set up is a main `.m` file that opens a session for the excel interface and allows for the sheets located in the excel document to be called by set variables. It also calls many functions that are made by the user, the first one called creates the entire structure of the data. The output is thrown straight into the write bungee data function that prints the structure into a `.txt` file. After that it selects the bungee cord's material and size that pass the specified constraints, and is put through a bubble sort. The results page is then set as active on the excel page and the display of all the bungees sorted that passed the constraints are printed into that page along with a graph of the displacement vs. time of the number one bungee material.

Data Structures

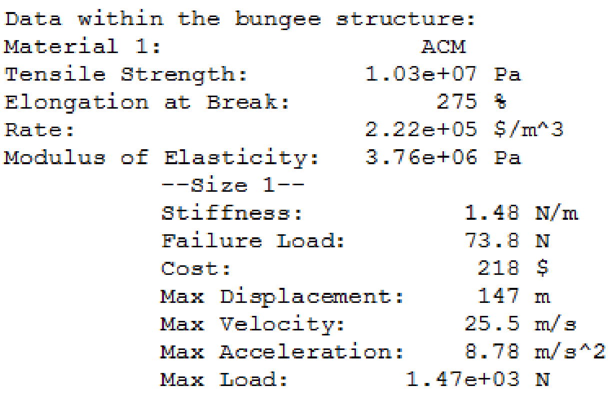
Since there are literately hundreds of calculations along with 190 different combinations of materials and sizes a data structure is needed to be able to call with little load on the computer. The base to the structure was straight forward having the specs sheet be put into a specs structure/matrix along with the calculations related to it, and the bungee page into a bungee structure/matrix along with the many calculations related to it.

Debugging and Testing

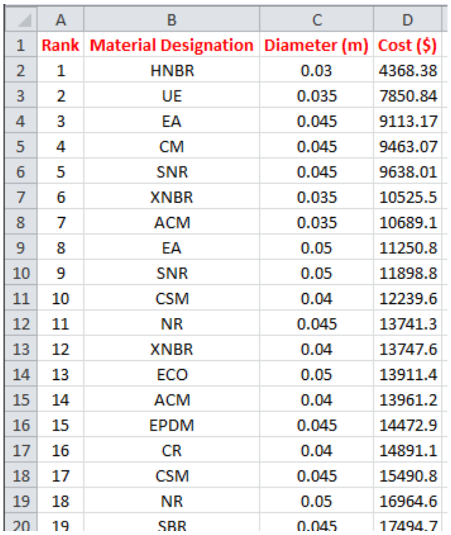
There were no big problems with my code when designing it, for the most part when I made code it was very broad and needed to be remade into a less complicated format. However when I ever got errors while testing I would use Matlabs built in debug method where you put a break near where you think the problem is and run it step by step pressing F10, this was similar in excel where F8 was needed. I never really needed to test by not knowing what values would change what, I used Matlabs help function to see what does what and excel I used Google to view example code.

Results

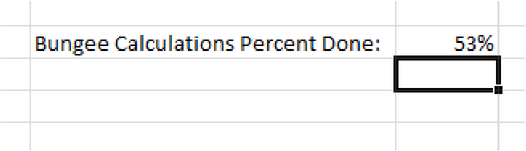
The results of the graph while all the formulas were not there that would be in real life the stress to the cord and all the information about the cord were a good output for an idea to see where is the best for the price. The .txt file shows an idea of what type of limits each cable has.



```
Data within the bungee structure:
Material 1:                    ACM
Tensile Strength:          1.03e+07 Pa
Elongation at Break:            275 %
Rate:                      2.22e+05 $/m^3
Modulus of Elasticity:     3.76e+06 Pa
           --Size 1--
           Stiffness:             1.48 N/m
           Failure Load:          73.8 N
           Cost:                   218 $
           Max Displacement:       147 m
           Max Velocity:          25.5 m/s
           Max Acceleration:      8.78 m/s^2
           Max Load:          1.47e+03 N
```



	A	B	C	D
1	Rank	Material Designation	Diameter (m)	Cost ($)
2	1	HNBR	0.03	4368.38
3	2	UE	0.035	7850.84
4	3	EA	0.045	9113.17
5	4	CM	0.045	9463.07
6	5	SNR	0.045	9638.01
7	6	XNBR	0.035	10525.5
8	7	ACM	0.035	10689.1
9	8	EA	0.05	11250.8
10	9	SNR	0.05	11898.8
11	10	CSM	0.04	12239.6
12	11	NR	0.045	13741.3
13	12	XNBR	0.04	13747.6
14	13	ECO	0.05	13911.4
15	14	ACM	0.04	13961.2
16	15	EPDM	0.045	14472.9
17	16	CR	0.04	14891.1
18	17	CSM	0.045	15490.8
19	18	NR	0.05	16964.6
20	19	SBR	0.045	17494.7



Bungee Calculations Percent Done:	53%

Conclusion

I think this program exceeds the requirements with a percentage done output (see above) on excel to track how far along the program is in its calculations. It also has an excel graph that was plotted from Matlab `.m` file not through the excel VBA editor, but having an excel graph allows for minor tweaks with it by the user that would be using the excel file if the `.exe` that would be given to the user didn't have things that was needed for a presentation. Verse the option to have Matlab plot it and output a photo that does not allow any changes. By making the graph through Matlab I have learned that there is no way axes titles are able to be changed though the code in Matlab and only changed though VBA editor or C#. I also have a better understanding of for loops being used with structures, not thinking they would be needed for that type of construction of data. I also learned how to use fprintf for outputs of files and not just outputting format into the Matlab command screen, this will be very useful in the future along with knowledge on how to use excel with Matlab. And to be honest I really never knew how to use excel before I started programing the VBA, it was very easy to learn. This project overall has allowed me to learn excel and Matlab in a new way other then it can do complicated math problems for you.