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 Gordon
%OEMP 3

clear;
clc;

%Initialize variables
L=27.25; %[ft]
w0=2001; %[lb/ft]
Error=zeros(1,50);
C=zeros(50,1);
WT=zeros(50,1);

%For loop that runs for p=1 through p=30. It first calls
 discretize_load and
%sends the result to moment_error. The error for each p value is
 stored
%in a vector called Error
for i=1:50
   p=i;
   Matrix=discretize_load(p,L,w0);
   Error(i)=moment_error(Matrix,L,w0);
   C(i)=500*(i^2);
   WT(i)=C(i)+Error(i);
end

%Plot p vs Error
% x=(1:50);
% plot(x,Error);
% hold on;
% xlabel('p (Number of Point Loads in Wiffle Tree)');
% ylabel('Error in the Bending Moment');
% title('Error vs p');
% hold off;

min=min(WT);
for j=1:50
    if WT(j)==min
        optimal_p=j;
    end
end

fprintf('The optimal number of distributed loads in the whiffle tree
 is p=%d\n',optimal_p);
fprintf('DISCLAIMER: If values show up as 0, it is not possible to
 make a beam in the one square foot value\n')

%Part 5 in OEMP 3 (not used to find the error in the bending moment)
[Force,Moment]=wall_reactions(Matrix);

% %% Different Materials
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% %Al 6061
E = 9.9*10^6;
Yield_Strength = 35000;
Shear_Ultimate = 27000;
roe = 0.098;
Cost = 8.03;
% %Steel 4130
% E=29*10^6;
% Yield_Strength = 70000;
% Shear_Ultimate = 54000;
% roe = 0.283;        %lb/in^3
% Cost = 8.07;        %[$]
% %Nickel 600
%  E = 30*10^6;
% Yield_Strength = 35000;
% Shear_Ultimate = 51000;
% roe = 0.304;
% Cost = 53.78;
% %Stainless 17-4
% E = 28.5*10^6;
% Yield_Strength = 115000;
% Shear_Ultimate = 81000;
% roe = 0.284;
% Cost = 29.63;
% %Titanium 6Al-4ZV
% E = 16.9*10^6;
% Yield_Strength = 120000;
% Shear_Ultimate = 80000;
% roe = 0.16;
% Cost = 115.36;


%length into inches
L_in = L*12;
```

The optimal number of distributed loads in the whiffle tree is p=14
DISCLAIMER: If values show up as 0, it is not possible to make a beam in the one square foot value

Calculations

```
%Score
F=4;
stepsize=F^(-1);

% Factor of safety matrices for different shapes
for i=stepsize:stepsize:12 % Solid Square
    area_square=i^2;
    [moment_square,~] = moment_total(L,w0,area_square,roe); %For
 1ft*1ft rectangle
    I_rectangle=(i*i^3)/12;
    y=i/2; %in
    stress_square=(moment_square*y)/I_rectangle;
```

```
    FS_square(:,i*F)=abs(Yield_Strength./stress_square);
    if FS_square(1,i*F) < 1.5+.25 && FS_square(1,i*F) > 1.5
       area_square_final=area_square;
       weight_square = roe*area_square_final*L_in;
       Dim_Square = i;
       break
    end


end
Price_Square = Cost*weight_square;
fprintf('The Price of the Square beam is: $%.2f with a side length of
 %.2f.\n',Price_Square,Dim_Square)


for r= stepsize:stepsize:6 % Circle
    area_circle=pi*r^2;
    [moment_circle,~] = moment_total(L,w0,area_circle,roe);
    I_circle=(pi*(r^4))/4;
    y=r;
    stress_circle=(moment_circle*y)/I_circle;
    FS_circle(:,r*F)=abs(Yield_Strength./stress_circle);
    if FS_circle(1,r*F) < 1.5+.7 && FS_circle(1,r*F) > 1.5
       area_circle_final=area_circle;
       weight_circle = roe*area_circle_final*L_in;
       Dim_Circle = r;
       break
%     elseif FS_circle(1,r*F) < 1.5+.35 && FS_circle(1,r*F) > 1.5
    end

end
Price_Circle = Cost*weight_circle;
fprintf('The Price of the Circle beam is: $%.2f with a radius length
 of %.2f.\n',Price_Circle,Dim_Circle)


for i=stepsize:stepsize:12 % Hallow Square
    area_hallow=i^2-(i-.5)^2;
    [moment_hallow,~] = moment_total(L,w0,area_hallow,roe);
    I_hallow=((i*i^3)/12)-(((i-.5)*(i-.5)^3)/12); %Check with TA
    y=i/2;
    stress_hallow=(moment_hallow*y)/I_hallow;
    FS_hallow(:,i*F)=abs(Yield_Strength./stress_hallow);
    if FS_hallow(1,i*F) < 1.5+.25 && FS_hallow(1,i*F) > 1.5
       area_hallow_final=area_hallow;
    weight_hallow = roe*area_hallow_final*L_in;
    Dim_Hallow = i;
    break
    end

end
Price_Hallow = Cost*weight_hallow;
```

```
fprintf('The Price of the Hallow Square beam is: $%.2f
 with a inner length of %.2f and an outter length of %.2f.
\n',Price_Hallow,Dim_Hallow-.5,Dim_Hallow)

for i=stepsize:stepsize:12 % I-beam
    area_top=.25*i;
    area_bottom=area_top;
    area_middle=.25*(i-.5);
    area_IBeam=area_top*2+area_middle;
    [moment_IBeam,Force_IBeam] = moment_total(L,w0,area_IBeam,roe);
%      I_IBeam=((i*i^3)/12)-(((i-.5)*(i-.5)^3)/12); %Check with TA
    I_top=(.5^3*i)/12;
    I_bottom=I_top;
    I_middle=((i-.5)^3*.25)/12;
    dy_middle=0;
    dy_top=(i/2)-.125;
    dy_bottom=-dy_top;
    I_IBeam=(I_top+area_top*dy_top^2)+(I_middle)+(I_bottom
+area_bottom*dy_bottom^2);
    y=(i)/2; % ?????
    stress_IBeam=(moment_IBeam*y)/I_IBeam;
    FS_IBeam(:,i*F)=abs(Yield_Strength./stress_IBeam);
    if FS_IBeam(1,i*F) < 1.5+.25 && FS_IBeam(1,i*F) > 1.5
     area_IBeam_Top = area_top;
     area_IBeam_Middle = area_middle;
        area_IBeam_final=area_IBeam;
    weight_IBeam = roe*area_IBeam_final*L_in;
    Dim_IBeam = i;
    break
    end

end
Price_IBeam = Cost*weight_IBeam;
fprintf('The Price of the IBeam is: $%.2f with a side length of %.2f
 with quarter inch thick sections.\n',Price_IBeam,Dim_IBeam)

for i=stepsize:stepsize:12 % T-beam
    area_top=.25*i;
    area_middle=.25*(i-.25);
    area_TBeam=area_top+area_middle;
    [moment_TBeam,~] = moment_total(L,w0,area_TBeam,roe);
    I_top=(.5^3*i)/12;
    I_middle=((i-.25)^3*.25)/12;
    normalAxis(i*F)=((i-.125)*area_top+((i-.25)/2)*area_middle)/
(area_TBeam);
    dy_top=(i-.125-normalAxis(i*F));
    dy_middle=normalAxis(i*F)-((i-.25)/2);
    I_TBeam=(I_top+area_top*dy_top^2)+(I_middle
+area_middle*dy_middle^2);
    y=normalAxis(i*F);
%      y2=i-normalAxis(i);
    stress_TBeam=(moment_TBeam*y)/I_TBeam;
%      stress_TBeam2=(moment_TBeam*y2)/I_TBeam;
    FS_TBeam(:,i*F)=abs(Yield_Strength./stress_TBeam);
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```
%     FS_TBeam2(:,i)=abs(70000./stress_TBeam2);
    if FS_TBeam(1,i*F) < 1.5+.25 && FS_TBeam(1,i*F) > 1.5
       area_TBeam_final=area_TBeam;
    weight_TBeam = roe*area_TBeam_final*L_in;
    Dim_TBeam = i;
    break
    else
        weight_TBeam = 0;
        Dim_TBeam = 0;
    end

end
Price_TBeam = Cost*weight_TBeam;
fprintf('The Price of the TBeam is: $%.2f with a side length of %.2f
 with quarter inch thick sections.\n',Price_TBeam,Dim_TBeam)

%Shear Force  = VQ/It
Y_bar_mid =  (3/4)*(area_IBeam_Middle/0.25);
Cent = Y_bar_mid * (area_IBeam_Middle/2);
Y_bar_top = Dim_IBeam - 0.125;
Cent2 = Y_bar_top*area_IBeam_Top;
Y_Bar = (Cent + Cent2)/ (area_IBeam_final/2);
Q = Y_Bar*(area_IBeam_final/2);
Shear = (Force_IBeam(1,1)*Q)/(I_IBeam*0.25);

%Shear Factor of Safety
FS_Shear = Shear_Ultimate/Shear;

%Uses MatLab built in integration to solve for deflection by
 integrating
%the moment equation twice and dividing by the youngs modulus times
 the
%moment of inertia.
syms W l x row area

f =(W/6)*((l-x)^2)*(1-(x/l))-((row*area)/2)*(l-x)^2;
integral = int(f,x);
integral2 = int(integral,x);
deflection = integral2/(I_IBeam*E);
Deflection = double(subs(deflection,{W,l,x,row,area},
{w0,L_in,L,roe,area_IBeam_final}));

fprintf('The wing will deflect %.2f inches\n',Deflection)
```

The Price of the Square beam is: $4117.27 with a side length of 4.00.
The Price of the Circle beam is: $5052.65 with a radius length of 2.50.
The Price of the Hallow Square beam is: $1479.64 with a inner length of 5.50 and an outter length of 6.00.
The Price of the IBeam is: $1174.07 with a side length of 6.25 with quarter inch thick sections.
The Price of the TBeam is: $0.00 with a side length of 0.00 with quarter inch thick sections.
The wing will deflect 38.17 inches

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