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DYNAMIC RESPONS OF COMPOSITE MADE CONTROL SURFACES.

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Abstract

For getting the free movement with high level and the high modulus of vibration for the several parts of aircraft that called for the control surfaces ,therefore we used the three metals that are using in the composite of control surfaces such as (Aluminum , Titanium and Carbon in two cases rod and plate) ,we calculated the frequencies for the three materials by using two programs (Matlab and Comsol) in many cases of examination ,such as bending, torsion, longitudinal axial with two positions of metals (Fixed in one end and with free) and by using rod, beam and plate ,also we were compared the results and the best metal will have the high frequency .From that we will conclude that carbon(C)is the best to use in composite of the control surfaces because the values of ω for this material are high than Aluminum(Al) and Titanium(Ti) and It is very difficult to use the Carbon alone in composite of the control surfaces because when the number of modes is increasing then the value of ω is increasing and that result to damage the part that made of carbon .

Introduction:

In a previous study we have studied the study of some of the materials involved in the composition of some parts of the aircraft and we found the three metals such as Aluminum , Titanium and Carbon These materials have good specifications such as(good heat transfer, Best strength to weight ratio and energy absorption , Smooth thin cell walls, Corrosion resistance Chemical resistance and heat resistance and not expensive)for Aluminum ,(Good dimensional stability and retention , High temperature property retention and high stiffness, Very low coefficient of thermal expansion , Relatively high shear modulus and very expensive)for Carbon ,and for Titanium (Young modulus and the weight are very high as compare with the two last materials) .

In this project we want to obtain control surfaces are made of materials which have high frequency.

The control surfaces of aircraft are consider very important for getting safe and stable flight and aircraft flight control surfaces allow a pilot to adjust and control the aircraft's flight attitude.

1- Properties of materials[4],[6]

Below the properties of the more important materials that use in control surfaces composite ,and we will choose the best three materials to have some calculations in different cases.

Table 1

Materials	Insulating	Energy,strenght And Stiffness	The size of cell and coefficient Of thermal expansion	The kinds of resistences	Electromagnetic Dielectric properties	The formability	The costs
1.Thermoplastic	Good insulating properties	Good energy absorption and/or redirection	Smooth cell walls	Moisture and chemical resistance	Environmentally compatible	Aesthetically pleasing	Have a relatively low cost
2.Aulminum	Has good heat transfer properties	Best strength to weigth ratio and energy absorption	Smooth thin cell walls	Corrosion resistance Chemical resistance and heat resistance	is not magnetic;	is a metal	Relatively low and is the third most abundant element in the Earth's crust cost
3.Steel	Good heat			Heat			

	transfer properties			resistance			
4.Specialty metal(Titanium)	Good heat transfer properties	Relatively high strength to weight ratio		Chemical resistance and heat resistance to very high temp.	is paramagnetic	is a transition metal	is the 9th most abundant element
5.Aramid paper	Good insulating properties			Flame resistant fire retardant	Low dielectric properties	Good formability	
6.Fiber glass	Good insulating properties			Tailorable shear properties by layup	Low dielectric properties	Good formability	
7.Carbon	Good dimensional stability and retention	High temperature Property retention and high stiffness	Very low coefficient Of thermal expansion	Relatively high shear modulus			Very expensive
8.Ceramic	Good insulating properties		Is available in very small cell sizes	Heat resistant to very high temp.			Very expensive

2. Vibration of structures made of Aluminum, Titanium and Carbon.

2.1. Technical description of Aluminum ,Titanium and Carbon . [7],[8],[9]

Below table (2) explain the Mechanical Properties of Aluminum ,Titanium and Carbon Materials

Table 2

The Materials	E= Young modulus in (n/m^2)	Density in (kg/m^3)	v=Poisson coefficient
Aluminum	69e9	2700	0.3
Titanium	110.3e9	4540	0.3
Carbon/Epoxy Composite Sheet/Longitudinal	70e9	1600	0.3
Carbon/Epoxy Composite Rod/Longitudinal	(120-140)e9	1600	0.3

2.2. Longitudinal(axial)Vibrations of Rod (Fixed at one end)[7],[8],[9],[10],[12].

In this case we will choose rod (fixed at one end) for each material and apply the longitudinal(axial)Vibrations and to get the Natural angular frequency and frequency and plot the relationship between the trasverse vibration of fixed bar both in arbitrary units w(AU) with the length of the fixed rod x(m).

In this case we will use the next equation to get the value of Natural angular frequency (rad/s):

W(n) =(2*n-1)*pi/(2*L)*sqrt(E/dens)

W(n)= Natural angular frequency (rad/s):

Pi = 3.14

L = Length of rod in (m)

E = Young modulus in (n/m^2)from schedule (2)

Dens = Density in (kg/m^3) from schedule (2)

n = number of modes

f(n)=W(n)/(2*pi)   frequency in (Hz)

And we will use next equation to plot this case for every(n):

$$u(x,t) = B\sin\left(\frac{\omega_n}{c_L}x\right)\cos\left(\omega_n t - \varphi_n\right)$$

Vibration modes

C L =sqrt(E/dens   Longitudinal waves velocity in (m/s)

B = Amplitued   amplitude own form in (m)

t = period   in second

Fay n = angle of phase

x = Long of rod in x-axies   in (m)

We will use four values of (n) in equation of (w) by Matlab program and we will get four values of (w) .We will use n =1,2,3 and 4 and we can see the values of w(n), f(n), respectively as shown below:

a- Aluminum[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=7941 rad/s and frequency (f)=3791 Hz.we note the curve started from zero toward the up and finished with one top at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=23822rad/s and frequency (f)=1263 Hz.we note the curve started from zero toward the bottom and the curve has two tops for up and down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=39704rad/s and frequency (f)=6319Hz.we note the curve started from zero toward the up and the curve has three tops(two for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=55585rad/s and frequency (f)=8846.7Hz.we note the curve started from zero toward the bottom and the curve has four tops(two for up and two tops for down) through x =1 (x=L=length of rod).

b-Titanium[10],[12].

Now we will discuss every case w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=7742 rad/s and frequency (f)=1232Hz.we note the curve started from zero toward down and finished with one top at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=23227rad/s and frequency (f)=3696Hz.we note the curve started from zero toward up and the curve has two tops for up and down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=38712rad/s and frequency (f)=6161Hz.we note the curve started from zero toward down and the curve has three tops(two for down and one for up) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=54197rad/s and frequency (f)=8625Hz.we note the curve started from zero toward up and the curve has four tops(two for up and two tops for down) through x =1 (x=L=length of rod).

c-Carbon[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=14159 rad/s and frequency (f)=2253 Hz.we note the curve started from zero toward down and finished with one top at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=42477 rad/s and frequency (f)=6760 Hz.we note the curve started from zero toward down and the curve has two tops for up and down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=70795rad/s and frequency (f)=11267Hz.we note the curve started from zero toward down and the curve has three tops(two for down and one for up) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=99113rad/s and frequency (f)=15774.7Hz.we note the curve started from zero toward down and the curve has four tops(two tops for up and two tops for down) through x =1 (x=L=length of rod).

2.3. Longitudinal(axial)Vibrations of Rod (Free at both end) [7],[8],[9],[10],[12].

In this case we will choose rod (free at both end) for each material and apply the longitudinal(axial)Vibrations to get the Natural angular frequency and frequency and plot the relationship between the transverse vibration of free rod both in arbitrary units w(AU) with the length of the rod x(m).

In this case we will use the next equation to get the value of Natural angular frequency (rad/s):

W(n)=n*pi/L*sqrt(E/dens)

W(n)= Natural angular frequency (rad/s):

Pi = 3.14

L = Length of rod in (m)

E = Young modulus in (n/m^2)from schedule (2)

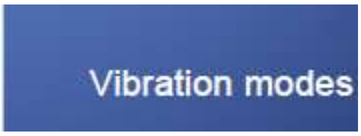
Dens = Density in (kg/m^3) from schedule (2)

n = number of modes

f(n)=W(n)/(2*pi) frequency in (Hz)

And we will use next equation to plot this case for every(n):

$$u(x,t) = A\cos\left(\frac{\omega_n}{c_L}x\right)\cos(\omega_n t - \varphi_n)$$



C L =sqrt(E/dens) Longitudinal waves velocity in (m/s)

B = Amplitued amplitude own form in (m)

t = period in second

Fay n = angle of phase

x = Long of rod in x-axies in (m)

We will use four values of (n) in equation of (w) by Matlab program and we will get four values of (w) .We will use n =1,2,3 and 4 and we can see the values of w(n), f(n), respectively as shown below:

a-Aluminum,[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=15882 rad/s and frequency (f)=2528 Hz.we note the curve started from down zero(negative area) toward up zero(positive area) and finished with one top at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=31763rad/s and frequency (f)=5055Hz.we note the curve started from down zero(negative area) toward up zero(positive area) and the curve has one top for up through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=47645rad/s and frequency (f)=7583Hz.we note the curve started from up zero(positive area) toward down zero(negative area) and the curve has two tops(one for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=63526rad/s and frequency (f)=10111.7Hz.we note the curve started from down zero(negative area) toward up zero(positive area) and the curve has three tops(two for up and one top for down) through x =1 (x=L=length of rod)

b-Titanium,[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=15485 rad/s and frequency (f)=2464 Hz.we note the curve started from down zero(negative area) toward up zero(positive area) and finished with one top at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=30970rad/s and frequency (f)=4929 Hz.we note the curve started from up zero(positive area) toward down zero(negative area) and the curve has one top for down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=46455rad/s and frequency (f)=7393Hz.we note the curve started from down zero toward up zero and the curve has two tops(one for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=61940rad/s and frequency (f)=9858Hz.we note the curve started from up zero toward down zero and the curve has three tops(two for down and one top for up) through x =1 (x=L=length of rod).

c-Carbon,[10],[12]

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=28320 rad/s and frequency (f)=4507 Hz.we note the curve started from upn zero toward down zero and finished at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=56640rad/s and frequency (f)=9014 Hz.we note the curve started from up zero toward down zero and the curve has one top for down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=84950rad/s and frequency (f)=13521Hz.we note the curve started from up zero toward down zero and the curve has two tops(one for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=113270rad/s and frequency (f)=18028.7Hz.we note the curve started from up zero toward down zero and the curve has three tops(one for up and two tops for down) through x =1 (x=L=length of rod).

2.4. Torsion Vibrations of Rod (Fixed at one end), [7],[8],[9],[10],[12].

In this case we will choose rod (fixed at one end) for each material and apply the Torsion Vibrations on the rod to get the Natural angular frequency and frequency and plot the relationship between the transverse vibration of fixed rod both in arbitrary units w(AU) with the length of the rod x(m).

In this case we will use the next equation to get the value of Natural angular frequency (rad/s):

W(n)=(2*n-1)*pi/2*L*Cr

W(n)= Natural angular frequency (rad/s)

Cr= sqrt(G/dens)

Cr = shear waves velocity (m/s)

G= E/2*(1+v)

G=shear modulus

v=Poisson coefficient

Pi = 3.14

L = Length of rod in (m)

E = Young modulus in (n/m^2)from schedule (2)

Dens = Density in (kg/m^3) from schedule (2)

n = number of modes

f(n)=W(n)/(2*pi)   frequency in (Hz)

And we will use next equation to plot this case for every(n):

Xn=C(n)*sin(((2*n-1)*pi/2*L)*x)   Vibration modes

C(n) = Amplitued   amplitude own form in (m)

x = Long of rod in x-axies   in (m)

We will use four values of (n) in equation of (w) by Matlab program and we will get four values of (w) .We will use n =1,2,3 and 4 and we can see the values of w(n), f(n), respectively as shown below:

a- Aluminum,[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=4925 rad/s and frequency (f)=783Hz.we note the curve started from zero toward the up and finished at x =1 (x=L=length of rod).
2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=14774rad/s and frequency (f)=2351Hz.we note the curve started from zero toward up and the curve has one top for up through x =1 (x=L=length of rod).
3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=24623rad/s and frequency (f)=3918Hz.we note the curve started from zero toward the up and the curve has two tops(one for up and one for down) through x =1 (x=L=length of rod).
4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=34473rad/s and frequency (f)=5486.7Hz.we note the curve started from zero toward up and the curve has three tops(two for up and one top for down) through x =1 (x=L=length of rod).

b- Titanium,[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=4802 rad/s and frequency (f)=764Hz.we note the curve started from zero toward up and finished at x =1 (x=L=length of rod).
2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=14405rad/s and frequency (f)=2292 Hz.we note the curve started from zero toward up and the curve has one top for up through x =1 (x=L=length of rod).
3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=24008rad/s and frequency (f)=3821Hz.we note the curve started from zero toward the up and the curve has two tops(one for up and one for down) through x =1 (x=L=length of rod).
4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=33612rad/s and frequency (f)=5349.7Hz.we note the curve started from zero toward up and the curve has four tops(two for up and one top for down) through x =1 (x=L=length of rod)

c-Carbon,[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=8781 rad/s and frequency (f)=1397 Hz.we note the curve started from zero toward up and finished at x =1 (x=L=length of rod).
2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=26343rad/s and frequency (f)=4192 Hz.we note the curve started from zero toward up and the curve has one top for up through x =1 (x=L=length of rod).
3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=43905rad/s and frequency (f)=6987Hz.we note the curve started from zero toward up and the curve has two tops (one for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=61467rad/s and frequency (f)=9782.7Hz.we note the curve started from zero toward up and the curve has three tops(two for up and one top for down) through x =1 (x=L=length of rod).

2.5. Torsion Vibrations of Rod (Free at both end) [7],[8],[9],[10],[13].

In this case we will choose rod (Free at both end) for each material and apply the Torsion Vibrations on the rod to get the Natural angular frequency and frequency and plot the relationship between the transverse vibration of free rod both in arbitrary units w(AU) with the length of the rod x(m).

In this case we will use the next equation to get the value of Natural angular frequency (rad/s):

W(n)=(n*pi/L)*Cr

W(n)= Natural angular frequency (rad/s)

Cr= sqrt(G/dens)

Cr = shear waves velocity (m/s)

G= E/2*(1+v)

G=shear modulus

v=Poisson coefficient

Pi = 3.14

L = Length of rod in (m)

E = Young modulus in (n/m^2)from schedule (2)

Dens = Density in (kg/m^3) from schedule (2)

n = number of modes

f(n)=W(n)/(2*pi) frequency in (Hz)

And we will use next equation to plot this case for every(n):

Xn=C(n)*cos((n*pi/L)*x) Vibration modes

C(n) = Amplitued amplitude own form in (m)

x = Long of rod in x-axies in (m)

We will use four values of (n) in equation of (w) by Matlab program and we will get four values of (w) .We will use n =1,2,3 and 4 and we can see the values of w(n), f(n), respectively as shown below:

a-Aluminum[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=9849rad/s and frequency (f)=1567 Hz.we note the curve started from up zero toward down zero and finished at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=19699rad/s and frequency (f)=3135 Hz.we note the curve started from up zero toward down zero and the curve has one top for down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=29548rad/s and frequency (f)=4702Hz.we note the curve started from up zero toward down and the curve has two tops(one for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=39397rad/s and frequency (f)=6270.7Hz.we note the curve started from up zero toward down and the curve has three tops(one for up and two tops for down) through x =1 (x=L=length of rod)

b-Titanium[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=9603rad/s and frequency (f)=1528 Hz.we note the curve started from up zero toward down zero and finished at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=19207rad/s and frequency (f)=3056Hz.we note the curve started from up zero toward down zero and the curve has one top for down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=28810rad/s and frequency (f)=4585Hz.we note the curve started from up zero toward down zero and the curve has two tops(one for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=38413rad/s and frequency (f)=61137Hz.we note the curve started from up zero toward down and the curve has three tops(one for up and tow tops for down) through x =1 (x=L=length of rod).

c-Carbon[10],[12].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=17562 rad/s and frequency (f)=2795 Hz.we note the curve started from up zero toward down zero and finished at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=35124rad/s and frequency (f)=5590Hz.we note the curve started from up zero toward down and the curve has one top for down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=52686rad/s and frequency (f)=8385Hz.we note the curve started from up zero toward down and the curve has two tops(one for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=70248rad/s and frequency (f)=11180.7Hz.we note the curve started from up zero toward the bottom and the curve has three tops(two for down and one tops for up) through x =1 (x=L=length of rod).

2.6. Bending Vibrations of simply supported beam[7],[8],[9],[10],[13].

In this case we will choose simply supported beam for each material and apply the Bending Vibrations on the beam to get the Natural angular frequency and frequency and plot the relationship between the transverse vibration both in arbitrary units w(AU) with the length of the beam x(m).

In this case we will use the next equation to get the value of Natural angular frequency (rad/s):

W(n)=sqrt(E*Iy/(dens*s))*(n*pi/L)^2

W(n)= Natural angular frequency (rad/s)

Iy=d^4*pi/64 cross-sectional moment of inertia (m^4)

d= diameter of cross-section area in unit meter

s= (d/2)^2*pi Area of cross-section (m^2)

Pi = 3.14

L = Length of rod in (m)

E = Young modulus in (n/m^2)from schedule (2)

Dens = Density in (kg/m^3) from schedule (2)

n = number of modes

f(n)=W(n)/(2*pi) frequency in (Hz)

And we will use next equation to plot this case for every(n):

Xn=C(n)*sin((n*pi/L)*x) Vibration modes

C(n) = Amplitued amplitude own form in (m)

x = Long of rod in x-axies in (m)

We will use four values of (n) in equation of (w) by Matlab program and we will get four values of (w) .We will use n =1,2,3 and 4 and we can see the values of w(n), f(n), respectively as shown below:

a-Aluminum[10],[13].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=249rad/s and frequency (f)=39 Hz.we note the curve started from zero toward up and finished with one top at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=997rad/s and frequency (f)=158Hz.we note the curve started from zero toward up and the curve has two tops for up and down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=2245rad/s and frequency (f)=357Hz.we note the curve started from zero toward up and the curve has three tops(two for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=3991rad/s and frequency (f)=635 Hz.we note the curve started from zero toward up and the curve has four tops(two for up and two tops for down) through x =1 (x=L=length of rod).

b-Titanium[10],[13].

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=243 rad/s and frequency (f)=38 Hz.we note the curve started from zero toward up and finished with one top at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=972rad/s and frequency (f)=154 Hz.we note the curve started from zero toward up and the curve has two tops for up and down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=2189rad/s and frequency (f)=348Hz.we note the curve started from zero toward up and the curve has three tops(two for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=3891rad/s and frequency (f)=6197 Hz.we note the curve started from zero toward up and the curve has four tops(two for up and two tops for down) through x =1 (x=L=length of rod)

c-Carbon [10],[13]

Now we will discuss every case between w(AU)(the transverse vibration in arbitrary units)and (x(m)=L=length of rod):

1- In case(1), number of mode(n)=1 , Natural angular frequency w(n)=444 rad/s and frequency (f)=70Hz.we note the curve started from zero toward up and finished with one top at x =1 (x=L=length of rod).

2- In case(2), number of mode(n)=2 , Natural angular frequency w(n)=1779rad/s and frequency (f)=283 Hz.we note the curve started from zero toward up and the curve has two tops for up and down through x =1 (x=L=length of rod).

3- In case(3), number of mode(n)=3 , Natural angular frequency w(n)=4003rad/s and frequency (f)=637Hz.we note the curve started from zero toward up and the curve has three tops(two for up and one for down) through x =1 (x=L=length of rod).

4- In case(4), number of mode(n)=4 , Natural angular frequency w(n)=7117rad/s and frequency (f)=1132 Hz.we note the curve started from zero toward up and the curve has four tops(two for up and two tops for down) through x =1 (x=L=length of rod).

2.7. Bending Vibrations of simply supported plate, [7],[8],[9],[10],[14].

In this case we will choose simply supported plate for each material and apply the Bending Vibrations to get the Natural angular frequency and frequency and plot the relationship between the transverse vibration both in arbitrary units w(AU) with the x and y of the plate.

In this case we will use the next equation to get the value of Natural angular frequency (rad/s):

W(mn)= pi^2*((m^2/a^2)+(n^2/b^2))*sqrt(D/(dens*h))

W(mn)= Natural angular frequency (rad/s)

D=(E*(h^3))/(12*(1-v^2)) Plate bending stiffness

a= Length of rod in (m)

b= Width of plate in(m)

h= height of plate in (m)

v=Poisson coefficient

Pi = 3.14

L = Length of rod in (m)

E = Young modulus in (n/m^2)from schedule (2)

Dens = Density in (kg/m^3) from schedule (2)

m= number of modes

n = number of modes

f(mn)=W(mn)/(2*pi) frequency in (Hz)

And we will use next equation to plot this case for every(n):

F=C*sin(m*pi*X/a).*sin(n*pi*Y/b) Vibration modes

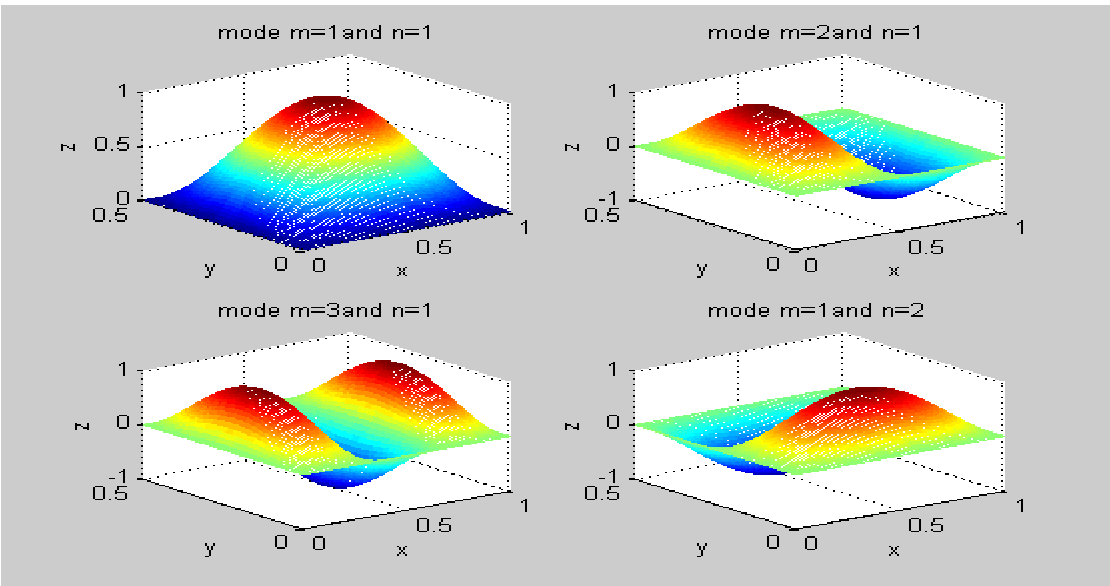
C= Amplitued amplitude own form in (meter)

y= Long of plate in y-axies in (m)

x = Long of plate in x-axies in (m)

We will use four values of (n) in equation of (w) by Matlab program and we will get four values of (w) .We will use m =1,2,3, 1 and n=1,1,1, 2 and we can see the values of w(mn),f(mn), respectively as shown below:

a-Aluminum,[10],[14].



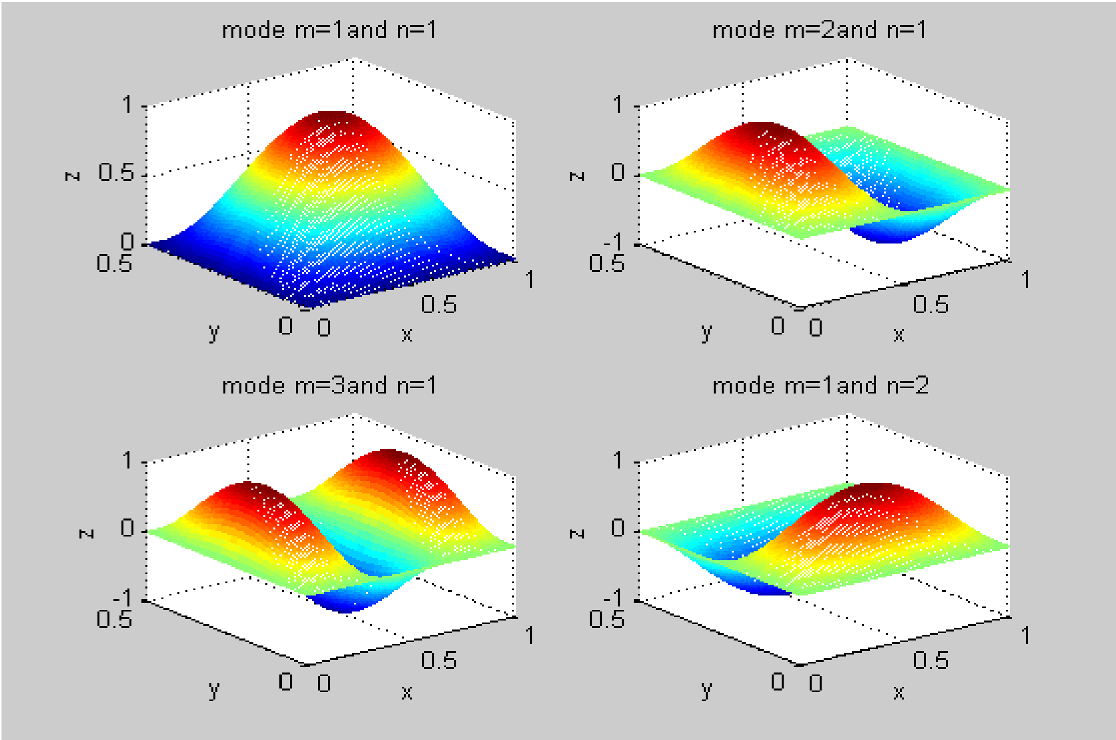
Now we will discuss every case in figures that have the relationship between w(AU)(the transverse vibration in arbitrary units)and with the x and y of the plate.

1- In figure(1), number of mode(m1n1) , Natural angular frequency w(m1n1)=75 rad/s and frequency (f)=12 Hz.we note the curve started from zero toward up and finished with one top .

2-In figure(2), number of mode(m2,n1) Natural angular frequency w(m2n1)=120rad/s and frequency (f)=19 Hz.we note the curve started from zero toward up and the curve has two tops for up and down .

3-In figure(3), number of mode(m3 ,n1) Natural angular frequency w(m3n1)=196rad/s and frequency (f)=31Hz.we note the curve started from zero toward up and the curve has three tops(tow for up and one for down).
4-In figure(4), number of mode(m1,n2) Natural angular frequency w(m1n2)=256 rad/s and frequency (f)=40 Hz.we note the curve started from zero toward down and the curve has two tops(one for up and one for down) .

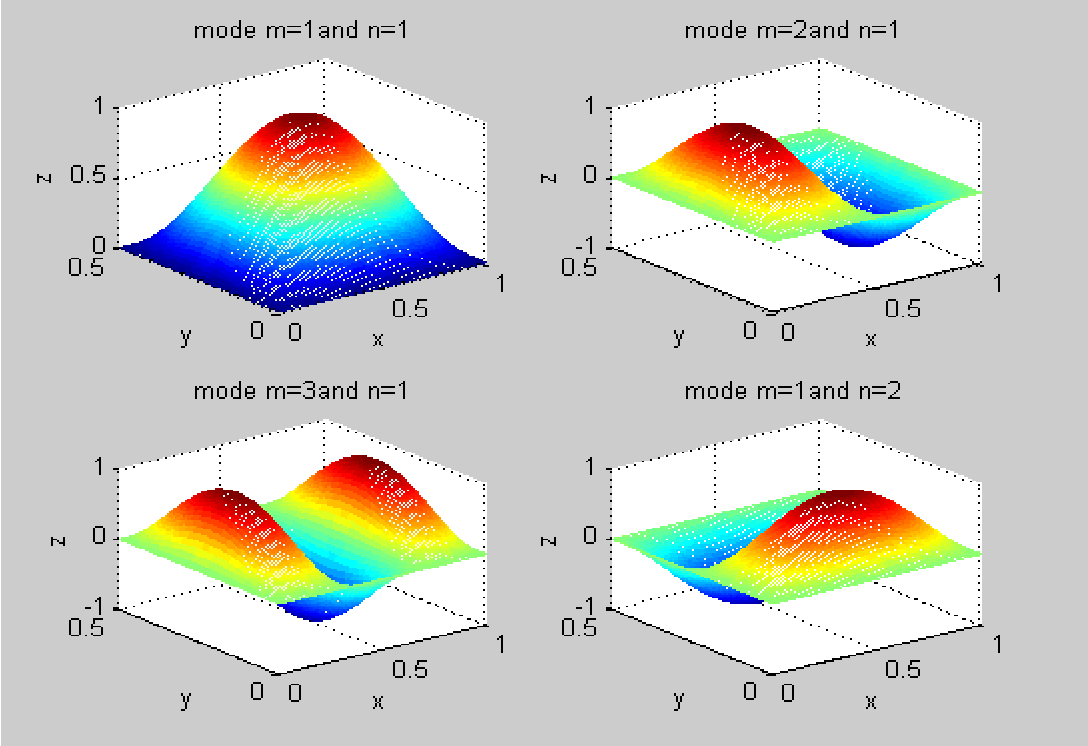
b-Titanium,[10],[14].



Now we will discuss every case in figures that have the relationship between w(AU)(the transverse vibration in arbitrary units) and with the x and y of the plate.

1- In figure(1), number of mode(m1,n1) Natural angular frequency w(m1n1)=73 rad/s and frequency (f)=11 Hz.we note the curve started from zero toward up and finished with one top .
2- In figure(2), number of mode(m2,n1) , Natural angular frequency w(m2n1)=117rad/s and frequency (f)=18 Hz.we note the curve started from zero toward up and the curve has two tops for up and down .
3- In figure(3), number of mode(m3,n1) , Natural angular frequency w(m3n1)=191rad/s and frequency (f)=30Hz.we note the curve started from zero toward up and the curve has three tops(two for up and one for down) .
4- In figure(4), number of mode(m1,n2) , Natural angular frequency w(m1n2)=250rad/s and frequency (f)=39 Hz.we note the curve started from zero toward down and the curve has two tops(one for up and one for down) .

c-Carbon,[10],[14].



Now we will discuss every case in figures that have the relationship between w(AU)(the transverse vibration in arbitrary units)and with the x and y of the plate.

1- In figure(1), number of mode(m1,n1) Natural angular frequency w(m1n1)=98 rad/s and frequency (f)=15 Hz.we note the curve started from zero toward up and finished with one top .
2- In figure(2), number of mode(m2n1) , Natural angular frequency w(m2n1)=158rad/s and frequency (f)=25 Hz.we note the curve started from zero toward up and the curve has two tops for up and down .
3- In figure(3), number of mode(m3,n1) , Natural angular frequency w(m3n1)=256rad/s and frequency (f)=40 Hz.we note the curve started from zero toward up and the curve has three tops(two for up and one for down) .
4- In figure(4), number of mode(m1,n2) , Natural angular frequency w(m1,n2)=335rad/s and frequency (f)=53 Hz.we note the curve started from zero toward down and the curve has two tops(two for up and one for down) .

3. Conclusions and future developments

When we Compare(ω)among Aluminum, Titanium and of Carbon by values of Natural angular frequency for each case in below

1- Longitudinal(axial)Vibrations of Rod (Fixed at one end).

Number of mode(n)	Natural angular frequency(w)(rad/s)	Aluminum(Al)	Titanium(Ti)	Carbon(Ca)
1	ω1	7941	7742	14159
2	ω2	23822	23227	42477
3	ω3	39704	38712	70795
4	ω4	55558	54197	99113

2- Longitudinal(axial)Vibrations of Rod (Free at both end).

Number of mode(n)	Natural angular frequency(w)(rad/s)	Aluminum(Al)	Titanium(Ti)	Carbon(Ca)
1	ω1	15883	15485	28320
2	ω2	31763	30970	56640
3	ω3	47645	46455	84950
4	ω4	63526	61940	113270

3- Torsion Vibrations of Rod (Fixed at one end).

Number of mode(n)	Natural angular frequency(w)(rad/s)	Aluminum(Al)	Titanium(Ti)	Carbon(Ca)
1	ω1	4925	4802	8781
2	ω2	14774	14405	26343
3	ω3	24623	24008	43905
4	ω4	34473	33612	61467

4- Torsion Vibrations of Rod (Free at both end).

Number of mode(n)	Natural angular frequency(ω)(rad/s)	Aluminum(Al)	Titanium(Ti)	Carbon(Ca)
1	ω1	9849	9603	17562
2	ω 2	19699	19207	35124
3	ω 3	29548	28810	52686
4	ω 4	39397	38413	70248

5- Bending Vibrations of simply supported beam

Number of mode(n)	Natural angular frequency(w)(rad/s)	Aluminum(Al)	Titanium(Ti)	Carbon(Ca)
1	ω1	249	243	444
2	ω2	997	972	1779
3	ω3	2245	2189	4003
4	ω4	3991	3891	7117

6- Bending Vibrations of simply supported plate

Number of mode(m,n)	Natural angular frequency(w)(rad/s)	Aluminum(Al)	Titanium(Ti)	Carbon(Ca)
1,1	ω1	75	73	98
2,1	ω2	120	117	158
3,1	ω3	196	191	256
1,2	ω4	256	250	335

We will conclude the following:

1-When the number of mode increases then the value of natural angular frequency(w) increases for each case.

2-There is a convergence in the values of natural angular frequency(ω) between Aluminum(Al) and Titanium(Ti) for each case.

3-The values of natural angular frequency(ω) for Carbon are very high compared Aluminum(Al) and Titanium(Ti) for each case.

4-From above conclude that carbon(C)is the best to use in composite of the control surfaces because the values of ω for this material are high than Aluminum(Al) and Titanium(Ti).

5-And Aluminum(Al) can be regarded as second only to carbon(C) to use in composite of control surfaces.

6-It is very difficult to use the Carbon alone in composite of the control surfaces because when the number of modes is increasing then the value of ω is increasing and that result to damage the part that made of carbon.

7-In the next time we will study using this materials(Al,Ti and C)alone or combined with other substances to get alloy stronger, harder, lighter, more resistance to corrosion or better in some other way to use it in composition this important parts in aircraft (control surfaces).

4. References

1.http://www.faa.gov/regulations_policies/handbooks_manuals/aviation/pilot_handbook/media/PHAK%20-%20Chapter%2005.pdf

2.https://en.wikipedia.org/wiki/Flight_control_surfaces

3.www.aeronautics.nasa.gov/pdf/.

4.http://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_airframe_handbook/media/ama_Ch07.pdf

5. http://www.azom.com/article.aspx?ArticleID=10859#2

6. http://www.differencebetween.net/object/difference-between-aluminum-and-titanium/

7.http://www.azom.com/article.aspx?ArticleID=1995

8. https://en.wikipedia.org/wiki/Young%27s_modulus

9. http://www.acpsales.com/upload/Mechanical-Properties-of-Carbon-Fiber-Composite-Materials.pdf

10. M.V.Predoi,"Vibratii Mecanice- Modele si aplicatii Matlab", Matrix Rom, Bucuresti 2011.

11.http://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_airfram e_handbook/media/ama_ch01.pdf

12. Courses noise and vibrations chapter 5

13. Courses noise and vibrations chapter 6

14. Courses noise and vibrations chapter 7.