Barrel Transverse Shear-Wave Natural Mode Frequencies (Calculated in MKS Units)

[Long-Range 50-Caliber Rifle Barrel Example: 50 BMG case, 850-gr copper bullet, 235-gr H-50BMG]

Barrel Inputs:	**Brit Eng Units**		**MKS Units**		
Length (L)	44.00	inches	1.117600	meters	
Caliber (d)	0.5100	inches	0.012954	meters	Mass=Rho*Vol=Rho*L*(Pi/4)*(D^2-d^2)
Barrel Mass (lbm, Kg)	8.00	lbm (pounds mass)	3.629	kg	**Suggested Barrel D= Ave. OD**
Average Diameter (D)	1.037539	inches	0.026353	meters	0.026353 meters
(4140 CroMo Steel)					1.037539 inches
Elasticity (E)	29,700,000	psi	204.78	Giga Pascals (GN/m^2)	N = kg*m/sec^2
Density (Rho)	490	lbm/foot^3	7849.05	kg/m^3	
Poisson's Ratio (Mu)	0.29		0.29		
Transverse Wave Speed	10662.73	fps	3250.00	m/sec	

Calculated Values:

Areal 2nd Mom (I) =	(Pi/32)*[D^4 - d^4]	4.4589E-08	meters^4	Barrel Volume (m^3) =	0.000462317
Cross-Section Area (A) =	(Pi/4)*[D^2 - d^2]	0.000413669	meters^2	Barrel Mass (kg) =	3.629
c = [E/Rho]^0.5 =		5107.76	meters/second	Acoustic-Wave Speed	
E*I =		9130.73	kg*m^3*sec^-2	Flexural rigidity	
I/A =		0.000107789	meters^2		
A*Rho =		3.2469	kg/meter	Mass per unit length	
SQRT[E*I/(A*Rho)] =		53.0295	m^2/second		
SQRT/L^2 =		42.4566	radians/second	Natural frequency constant	
Peak Base Pres. Time (QL)		680	microseconds	Start of Barrel Vibrations	

2*Pi*f(n) = [a(n)/L^2]*SQRT[E*I/(A*Rho)]

Clamped-Free Ends:		**omega(n) Mode Freqencies**	**f(n) Mode Freqencies**	**1/[4*f(n)] Quarter Period**	**1/[2*f(n)] Half Period**
Mode No. (n)	**a(n) [Blevins]**	**(Radians/sec)**	**(hertz)**	**(microsec)**	**(microsec)**
1	3.52	149.45	**23.79**	10511	21021
2	**22.40**	**951.03**	**151.36**	**1652**	**3303**
3	61.70	2619.57	**416.92**	600	1199
4	121.00	5137.24	**817.62**	306	612
5	199.90	8487.07	**1350.76**	185	**370**
6	298.60	12677.53	**2017.69**	124	**248**
7	416.99	17703.96	**2817.67**	89	**177**