For a car to ride comfortably the rear springs should have between 80 & 100 double vibrations per min. A 4" deflection gives about 92 per min. For the front spring a 2" to 3" deflection is quite sufficient.

Period for 1 complete oscillation

$$t = 2\pi\sqrt{\frac{l}{g}}$$

where t = time in secs.
l = spring deflection in feet
g = 32.2

no. of oscillations = $\frac{60}{t}$ per min

If these do not come within the range specified the plates must then be adjusted to give correct results. If to many vibrations thinner plates are necessary. The can be obtained from table to give the same strength for greater deflection

For laminated springs 1 lb of spring for every 4 ft. lbs of energy as minimum

L = distance in ft.

Eg:- Front Spring

$$N = \frac{1.5\,W\,L}{f\,b\,t^2}$$

Centres = 2' - 10"
Clips = 3"
W = 700 lbs
$1\frac{3}{4}$" wide & assume $\frac{3}{16}$" plates

$$N = \frac{1.5 \times 700 \times 34}{75{,}000 \times 1.75 \times (.187)^2} = 7.8 - \tfrac{3}{16} \text{ plates}$$

Say $6 - \frac{3}{16}$ and $1 - \frac{1}{4}$"

$$\alpha = \frac{700 \times (31)^3}{2240 \times 42{,}000}$$

Eq. of Spring Steel (Fried Krupp)

Max Tensile	Elastic Limit
1 90 tons / □" 2 200,000 lbs / □"	75 tons / □" 170,000 lbs / □"
Elongation	**Permissible Stress**
1 5% 2	75,000 lbs / □" 60,000 lbs / □"

1) Pleasure cars
2) Heavy commercial vehicles

The strength of plates considered as a beam is proportional to the square of the thickness. The stiffness of plates is proportional to the cube of the thickness.

Taking $\frac{1}{4}$" as a unit

Thickness of plate	Strength	Stiffness
3/16	·56	·423
7/32	·767	·673
1/4	1·000	1·000
9/32	1·26	1·42
5/16	1·56	1·95
3/8	2·24	3·38
7/16	3·33	5·36
1/2	4·0	8·0
9/16	5·06	11·4
5/8	6·25	15·7

Resilence of Mat[l].

The amount of energy in ft.lbs which can be absorbed in one cubic in. of mat[l] without causing permanent set / is —

$$PE = \frac{W\,L}{2} \text{ ft.lbs}$$

L = Deflection in feet
W = Weight in lbs.

$$B.H.P. = \frac{A^{\square''} \times S'' \times R.P.M \times M.E.P \times N.}{792,000}$$

$$MEP = \frac{BHP \times 792000}{A^{\square''} \times S'' \times R.P.M. \times N}$$

Compression pressure = $P_1 \times (R)^c$

Where P_1 = atmospheric pressure
R = compression ratio
c = constant (about 1.3)

$$R = \frac{V_1}{V_2} = \frac{\text{Initial Volume}}{\text{Vol of compression space}}$$

$$\therefore P_2 = P_1 \cdot \left(\frac{V_1}{V_2}\right)^c$$

$$B.H.P. = \frac{P.A.S.N.E}{33{,}000 \times 4}$$

where P = M.E.P in lbs per sq
A = area of piston in sq
S = piston speed in ft/
N = no. of cylinders
E = mechanical efficien

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = 2R.$$

$$a = c \cos B + b \cos C$$

$$c^2 = a^2 + b^2 - 2ab \cos C$$

also $\cos C = \dfrac{a^2 + b^2 - c^2}{2ab}$

$$\sin A = \frac{2}{bc}\sqrt{s(s-a)(s-b)(s-c)}$$

$$\sin A = \frac{1}{\operatorname{cosec} A} \; ; \quad \operatorname{cosec} A = \frac{1}{\sin A}$$

$\cot \times \tan = 1$ $\qquad \dfrac{\sin}{\cos} = \tan.$

$\sin \times \operatorname{cosec} = 1$

$\cos \times \sec = 1$ $\qquad \dfrac{\cos}{\sin} = \cot.$

$$\sin^2 + \cos^2 = 1$$

$$\sec^2 = \tan^2 + 1.$$

$$\operatorname{cosec}^2 = \cot^2 + 1$$

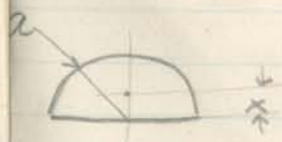
$$(\sin + \cos)^2 = 1 + 2 \sin . \cos.$$

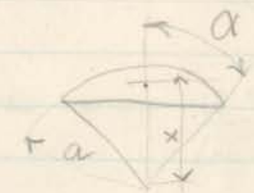
$$(\sin - \cos)^2 = 1 - 2 \sin . \cos.$$

$$\frac{\cos^2}{\cot^2} = 1 - \cos^2$$

C.G. of semi circle

$$x = \frac{4a}{3\pi}$$

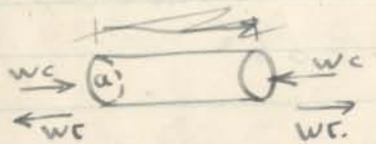


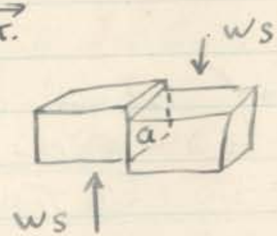


C.G. = segment. $x = a \cdot \dfrac{\sin \alpha}{\alpha}$

$$(a+x)^n = a^n + n a^{n-1} x + \frac{n(n-1)}{1.2} a^{n-2} x^2 + \frac{n(n-1)(n-2)}{1.2.3} a^{n-3} x^3 \text{ etc.}$$

$$(a-x)^n = a^n + n a^{n-1}(-x) + \frac{n(n-1)}{1.2} a^{n-2}(-x)^2 + \frac{n(n-1)(n-2)}{1.2.3} a^{n-3}(-x)^3$$





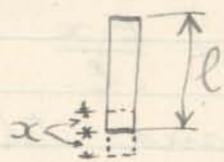
3. Kinds of stress. viz.
Tension, compression, & shear.
These are stated in lbs. per unit area.
Where ~~W~~ W equal load and a the area of cross section

$$Ft = \frac{W}{a}, \quad Fc = \frac{W}{a}, \quad Fs = \frac{W}{a}$$

Tension and compression strains are measured by the increase or decrease of length divided by ~~the~~ the original length.

Where l = original length and
x = increase$^{(t)}$ or decrease$^{(c)}$

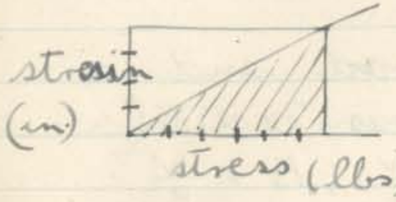
$$\text{strain} = \frac{x}{l}.$$



$$\text{shear strain} = \frac{a'}{b}$$

Hookes Law states that

$$\frac{\text{stress}}{\text{strain}} = \text{constant}$$



work done (in.lbs.) = shaded area

Elastic constants. (Youngs modulus)

$$\frac{\frac{w}{a}}{\frac{x}{l}} = \text{constant } (E)$$

$\therefore$ if E is known
we can find the stress which
will produce a given strain

$$\frac{w}{a} = \frac{Ex}{l}$$

and the strain that will
be produced by a given stress

$$\frac{x}{l} = \frac{\frac{w}{a}}{E}$$

$$x = \frac{Wl}{aE}, \quad w = \frac{Exa}{l}$$

The coefficient of rigidity G
is the the same relation
applied to shear strains

$$\frac{\frac{w}{a}}{\frac{a'}{b}} = \text{constant } (G)$$

the coefficient of volume
elasticity, K, is the ratio $\frac{\text{stress}}{\text{strain}}$
applied to a body subjected to
a uniform pressure in all
directions (such as a body
immersed in a fluid)

$$\therefore \frac{\text{pressure}}{\text{change of vol.}} = K.$$

Poissons ratio.

When a bar is compressed
longitudinally it expands
laterally & the ~~the~~ ratio
$\frac{\text{lat. strain}}{\text{long. strain}} = \frac{1}{4}$ for most material.

the ratio is usally dentoted by 'n'