

## Structural Eccentric Mass Vibrators

ANCO Eccentric mass vibrators are attached to equipment and structures to determine their response to sinusoidal forcing over a range of frequencies in order to estimate resonant frequencies, damping, mode shapes, and other dynamic properties (modal properties). Knowledge of actual dynamic properties can be used to validate and improve analytical models, reveal margins unjustifiable by analysis alone, determine non-linear properties, detect damage, and perform basic research into the dynamics of structures and structural components.

In addition to the vibrator, motion transducers and a PC-based data acquisition and vibrator control system is available (ANCO FOVDAR). All ANCO vibrators are field portable, even in remote areas, and can usually be set up in a few hours. ANCO vibrators have been used to test a variety of structures, including dams, boiler structures, nuclear power plant containments and equipment, foundations, bridges, offshore oil platforms, ships, stacks, floors, office buildings, piping systems, isolated structures, and storage tanks.

Eccentric mass vibrators use one or more rotating eccentric weights to produce a force which increases in direct proportion to the eccentricity and to the square of the rotating frequency. The force produced is thus given by the relationships:

$$F_{lbs} = 0.102 * WR * f^2$$

$$F_{Newtons} = E * \omega^2$$

$WR$  : eccentricity in lb-inches

$E$  : eccentricity in Kg-m

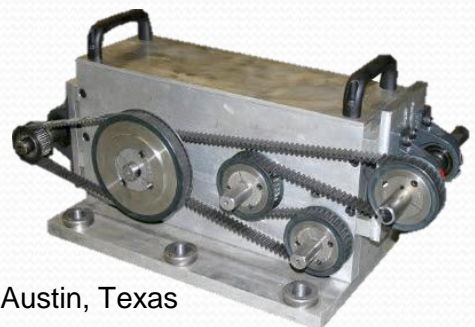
$f$  : frequency in Hz

$\omega$  : frequency in radians/sec

A single eccentric weight produces an omnidirectional rotating force vector, which can be expressed as a combination of two perpendicular sinusoidal forces, with a 90 degree phase shift between them. The use of equal counter rotating eccentric weights produces a unidirectional sinusoidal force. Most eccentric weights are adjustable from zero to 100% eccentricity, either continuously or in steps. This allows a wide range of frequencies to be covered with approximately the same force. Two or more vibrators, spaced apart on a structure, can provide torsional forcing, or enhance the motion of one particular mode over another. Multiple vibrators must be synchronized electronically which requires a more advanced control system. Almost all vibrators allow for horizontal forcing. Some also allow vertical forcing (or forcing at an arbitrary angle to the horizontal), but this requires larger drive units in order to overcome the torque produced by gravity on the eccentric weights.



**MK15** UCLA/NEES, California



**MK130** University of Austin, Texas

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Most vibrators are driven by variable speed electric motors. The size of the motor will depend on the size of the vibrator (internal friction, windage) and the amplitude of the motion achieved on the structure being tested. Often a vibrator is provided with a transmission to allow near full power over a wide frequency range. Speed control accuracy is at least 1 part in 300 of full speed, and greater accuracies are possible.

ANCO has provided eccentric mass vibrators to over 30 different universities, research groups, and test laboratories since 1971. The table below summarizes the range of eccentric mass vibrators available from ANCO. Any of these design parameters can be modified to meet a client's specific needs. Any of these units can be configured into synchronized multiple vibrators. Contact ANCO for additional details or custom designs.

## ANCO Structural Eccentric Mass Vibrator Product List

Model Family	Peak Force kips (kN)	Eccentricity Lb-in (kg·m)	Upper Frequency (Hz)	Drive Power HP (kW)	System Weight (tons)
<b>MK100</b>	0.2 (0.9)	0.1 (0.0012)	300	1 (0.7)	0.005
<b>MK110</b>	4 (18)	10 (0.12)	200	2 (1.4)	0.02
<b>MK120</b>	10 (44)	50 (0.58)	100	5 (3.5)	0.07
<b>MK130</b>	20 (88)	400 (4.6)	30	5 (3.5)	0.15
<b>MK140</b>	20 (88)	4,000 (46)	30	10 (7)	0.3
<b>MK150</b>	20 (88)	40,000 (460)	20	10 (7)	1.0
<b>MK160</b>	100 (440)	120,000 (1,400)	25	50 (35)	1.5
<b>MK170</b>	1000 (4,400)	1,000,000 (11,500)	15	100 (70)	10.0
<b>MK180</b>	4,000 (17,600)	18,000,000 (208,000)	10	500 (350)	80.0

**MK180 HDR Frankfurt, Germany**

