AMTI FORCE PLATFORM CALCULATIONS

MOMENT CALCULATIONS

In our previous newsletter, we explained the AMTI force platform coordinate system and presented the equations used to calculate the center-of-pressure (COP). In this newsletter, we derive the COP equations.

AMTI force platforms produce six signals. Three outputs are the forces F_x, F_y, and F_z, and three are the moments M_x, M_y, and M_z. In most biomechanics applications, the horizontal-moment outputs M_x and M_y are proportional to the center-of-pressure location on the platform and the vertical moment includes the torque about the vertical axis. In both cases, the moment values are used to calculate useful parameters for biomechanics.

Each of the moments measured by the AMTI force platform include couple and the moment of force terms (a couple is equivalent to two non-colinear, parallel forces acting in opposite directions, and a moment of force with respect to a point is the product of the force and the perpendicular distance from the point to the force vector). For instance:

$$M_z = - F_x*y + F_y*x + T_z \quad (1)$$

Here, the vertical moment output of the AMTI force platform (M_z) is the sum of two moment of force terms (F_x*y and F_y *x) and a couple (T_z). The negative sign in front of the F_x*y term is a result of the "right-handed" coordinate system used in the AMTI force plates, as discussed in a previous issue of this newsletter.

The couple, T_z, is the quantity sought in biomechanics studies. It is calculated using a variation of equation 1:

$$T_z = M_z + F_x*y - F_y*x \quad (2)$$

This equation shows that the vertical torque acting on the foot can be calculated from the AMTI force platform outputs by correcting M. for the shear force contributions to the vertical moment signal.

The signals for the horizontal moments are similar to the vertical output (d_z= plate thickness= 41.3 mm):

$$M_x = F_z*y + F_y*d_z + T_x \qquad M_y = -F_z*x - F_x*d_z + T_y \quad (3 \text{ and } 4)$$

In most biomechanics applications, there is no couple, T_x or T_y. When an individual stands or walks on an AMTI force plate, the only way to induce a couple about a horizontal axis is to attach their foot to the platform so they can twist the top surface about the X or Y axis. Otherwise, there is no T_x or T_y value and these equations can be used to calculate the X and Y coordinates of the center-of-pressure:

$$x = - (M_y + F_x*d_z) /F_z \qquad y = (M_x - F_y* d_z) /F_z \quad (4 \text{ and } 5)$$

These equations are not valid if the subject uses footstraps or handgrips attached to the platform. but they are appropriate for walking, running and other common biomechanics studies.