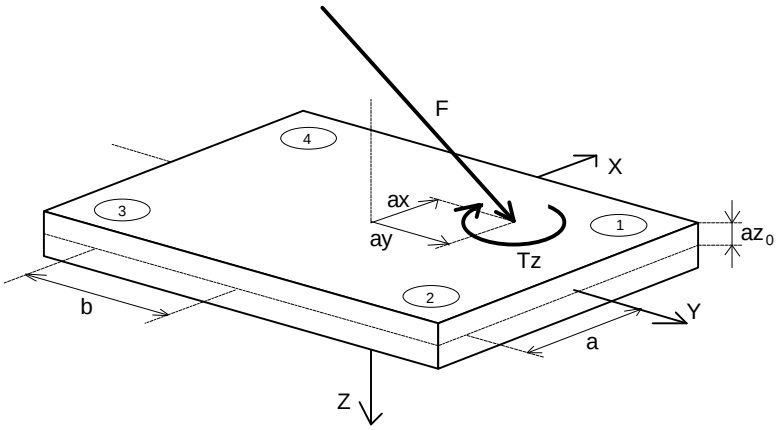
Kistler Force Plate Formulae



Force plate output signals

Output signal	Channel	Description
fx12	1	Force in X-direction measured by sensor 1 + sensor 2
fx34	2	Force in X-direction measured by sensor 3 + sensor 4
fy14	3	Force in Y-direction measured by sensor 1 + sensor 4
fy23	4	Force in Y-direction measured by sensor 2 + sensor 3
fz1 ... fz4	5 ... 8	Force in Z direction measured by sensor 1 ... 4

Calculated parameters

Parameter	Calculation	Description
Fx	= fx12 + fx34	Medio-lateral force 1)
Fy	= fy14 + fy23	Anterior-posterior force 1)
Fz	= fz1 + fz2 + fz3 + fz4	Vertical force
Mx	= b * (fz1 + fz2 - fz3 - fz4)	Plate moment about X-axis 3)
My	= a * (-fz1 + fz2 + fz3 - fz4)	Plate moment about Y-axis 3)
Mz	= b * (-fx12 + fx34) + a * (fy14 - fy23)	Plate moment about Z-axis 3)
Mx'	= Mx + Fy*az0	Plate moment about top plate surface 2)
My'	= My - Fx*az0	Plate moment about top plate surface 2)
ax	= -My' / Fz	X-Coordinate of force application point (COP) 2)
ay	= Mx' / Fz	Y-Coordinate of force application point (COP) 2)
Tz	= Mz - Fy * ax + Fx * ay	Free moment, Vertical torque, „Frictional“ torque
COFx	= Fx/Fz	Coefficient of Friction x-component
COFy	= Fy/Fz	Coefficient of Friction y-component
COFxy	= sqrt (COFx^2 + COFy^2)	Coefficient of Friction absolute

All formulae are in Kistler coordinate system

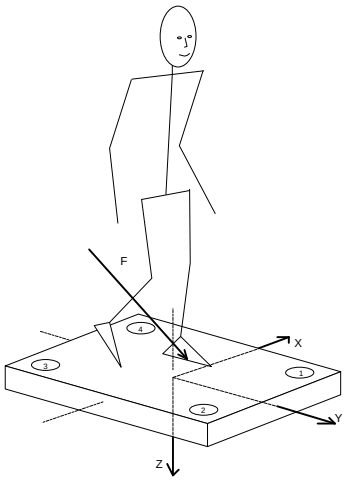
1) Walking direction is positive Y-axis

2) az0 = top plane offset (negative value)

3) a, b = sensor offset (positive values)

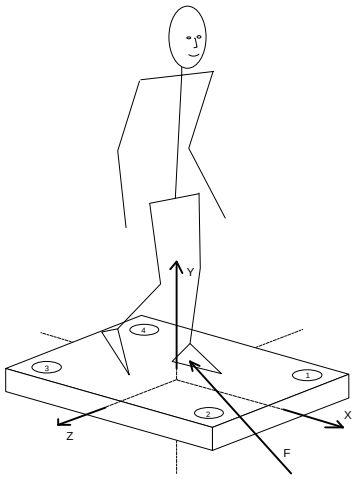
Coordinate systems

Kistler

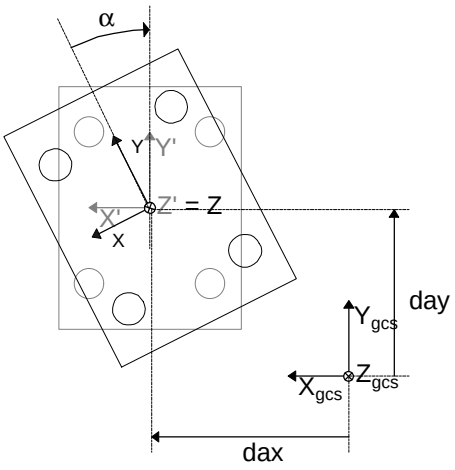


-Fy	=	Fx
Fz	=	Fy
Fx	=	Fz
-My	=	Mx
Mz	=	My
Mx	=	Mz
-My'	=	Mx'
Mx	=	Mz'
ay	=	ax
-ax	=	az
Tz	=	Ty

ISB (reactionary)



Different coordinate system of one force plate



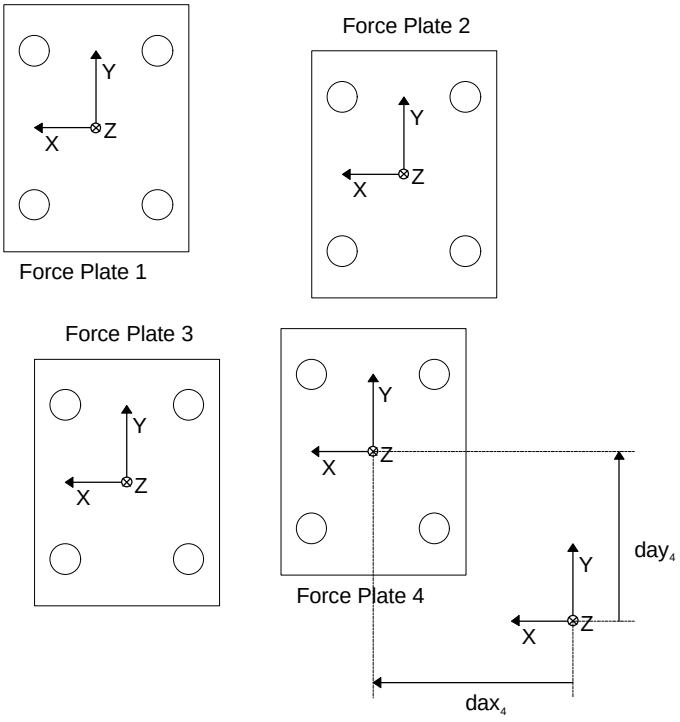
Parameter	Calculation
Fx_{gcs}	(Fx * cos α) + (Fy * sin α)
Fy_{gcs}	(Fy * cos α) - (Fx * sin α)
Fz_{gcs}	Fz
Mx_{gcs}	ay_{gcs} * Fz_{gcs}
My_{gcs}	-ax_{gcs} * Fz_{gcs}
Mz_{gcs}	(ax_{gcs} * Fy_{gcs}) - (ay_{gcs} * Fz_{gcs})
Mx'_{gcs}	Mx_{gcs} + (az0 * Fy_{gcs})
My'_{gcs}	My_{gcs} - (az0 * Fx_{gcs})
ax_{gcs}	dax + (ax * cos α) + (ay * sin α)
ay_{gcs}	day + (ay * cos α) - (ax * sin α)
Tz_{gcs}	Tz

Global coordinate system (treat multiple force plates as one)

The following formulae are used if one or several force plates have to be transformed into one global coordinate system and if several force plates have to be treated as one large plate.

A global coordinate system has to be defined relative to which the center of each force plate is offset by dax, day.

If a force plate is not only offset but also rotated, a coordinate transformation (rotation) around its center has to be performed (see preceeding chapter). This brings the data of the force plate data into the same direction as the reference coordinate system.



Description of parameters:

dax_i, day_i	Offset of center of each plate relative to global coordinate system
Fx_i, Fy_i, Fz_i	Resulting force components of each plate
ax_i, ay_i	Center of pressure coordinates of each plate
$az0_i$	Thickness parameter az0 of each plate

Global Parameter	Calculation
Fx	$= Fx_1 + Fx_2 + ... + Fx_n$
Fy	$= Fy_1 + Fy_2 + ... + Fy_n$
Fz	$= Fz_1 + Fz_2 + ... + Fz_n$
Mx	$= (day_1+ay_1)*Fz_1 + (day_2+ay_2)*Fz_2 + ... + (day_n+ay_n)*Fz_n$
My	$= -(dax_1+ax_1)*Fz_1 - (dax_2+ax_2)*Fz_2 - ... - (dax_n+ax_n)*Fz_n$
Mx'	$= Mx + az0_1*Fy_1 + az0_2*Fy_2 + ... + az0_n*Fy_n$
My'	$= My - az0_1*Fx_1 - az0_2*Fx_2 - ... - az0_n*Fx_n$
ax	$= -My' / Fz$
ay	$= Mx' / Fz$
Mz	$= [(dax_1 + ax_1)*Fy_1 - (day_1 +ay_1)*Fx_1] + ... + [(dax_n + ax_n)*Fy_n - (day_n +ay_n)*Fx_n]$
Tz	$= Mz - Fy * ax + Fx * ay$