United States Institute for Theatre Technology
RP-4
Recommended System for Labeling Rigging Unknowns

Introduction

There is much confusion in the entertainment industry about the letters used when solving problems associated with force distribution, bridle geometry and force calculations. In training young riggers, instructors have each created their own logical lettering system for unknowns. There have been two problems with these systems. The first is that all this was done independently without anyone really consulting anyone else. The second is that the lettering system was not always really entirely thought out.

Almost all the formulas needed by riggers deal with either force or distance. Starting with these two variables the system uses ***F*** for force and ***D*** for distance. In most cases there will be more than one force or distance used in a formula or series of formulas. In these cases the forces and distances need to be qualified by the use of subscripts.

Table of Contents

FORCE DISTRIBUTION PROBLEM LABELS

In force distribution problems the new system would work as follows:
S = the horizontal distance between supports
D_1 = the horizontal distance from the applied force to support one
D_2 = the horizontal distance from the applied force to support two
F_A = the force (load) applied to the support structure being analyzed
F_1 = the force at anchorage one
F_2 = the force at anchorage two

The use of the letter **S** for the distance between supports (span) has been universally used for the distance between supports and between bridle anchorages in the case of two-legged bridles, and so has been kept in this system even though it is an exception to the rule of using the letter D for distances.

If there is more than one applied force being dealt with the form would be F_{A1}, F_{A2} etc. The distances associated with multiple applied forces would be labeled D_{1A2}, D_{1A2}, D_{2A1}, etc.

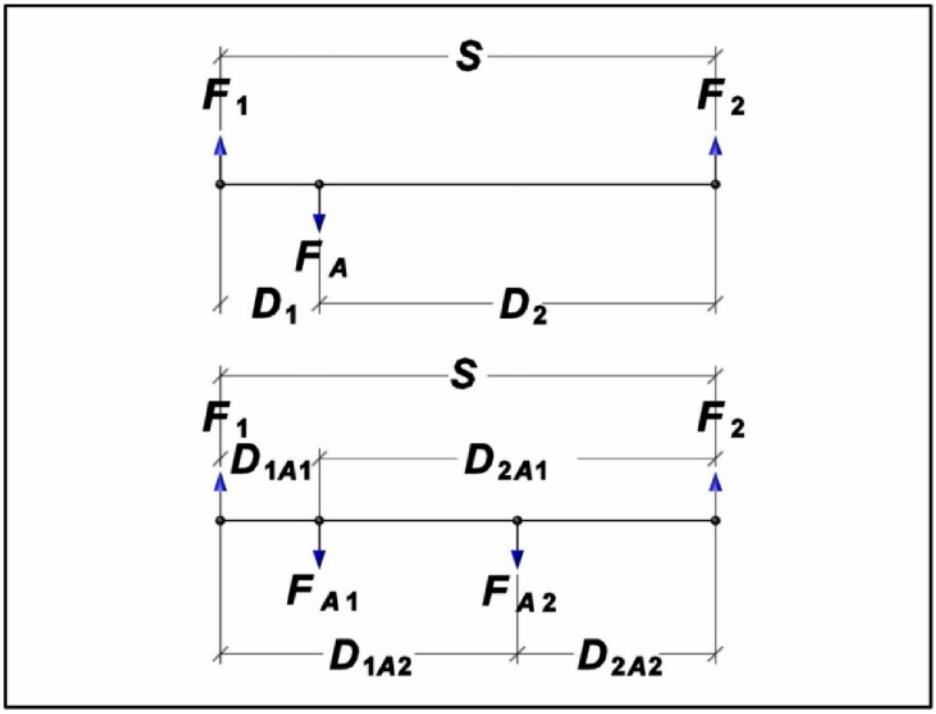

Figure1. Force Distribution Labels

The simple distribution formula would end up in this form:

$$F_1 = \frac{F_A D_2}{S}$$

A more complex formula incorporating more than one applied load would look like this:

$$F_1 = \frac{F_{A1} D_{2A1} + F_{A2} D_{2A2}}{S}$$

BRIDLE LABELS

All but the most complicated rigging is accomplished by using either two-legged or three-legged bridles. A two-legged bridle forms a triangle with the vertices being the two anchorages and the bridle point. The labels for these points are as are used to identify the points in space when required and in addition are used for the identification of angles when required. Below are the labels for the points associated with both two and three-legged bridle geometry.

Points (Vertices)
$\boldsymbol{A_1}$ = the attachment or anchorage for leg one of a bridle
$\boldsymbol{A_2}$ = the attachment or anchorage for leg two of a bridle
$\boldsymbol{A_3}$ = the attachment or anchorage for leg three of a bridle
P = the bridle point

There are cases when the applied force is not vertical and the angles associated with the applied force and its component forces are required. The origin of the applied force is at the bridle point (***P***), however the letter P is associated with bridle angles, so when analyzing the applied force the vertex is labeled ***O***. The vertex at the opposite end or termination of the force vector is ***T***.

O = the origin of the applied force (same point in space as ***P***)
T = the termination of the applied force

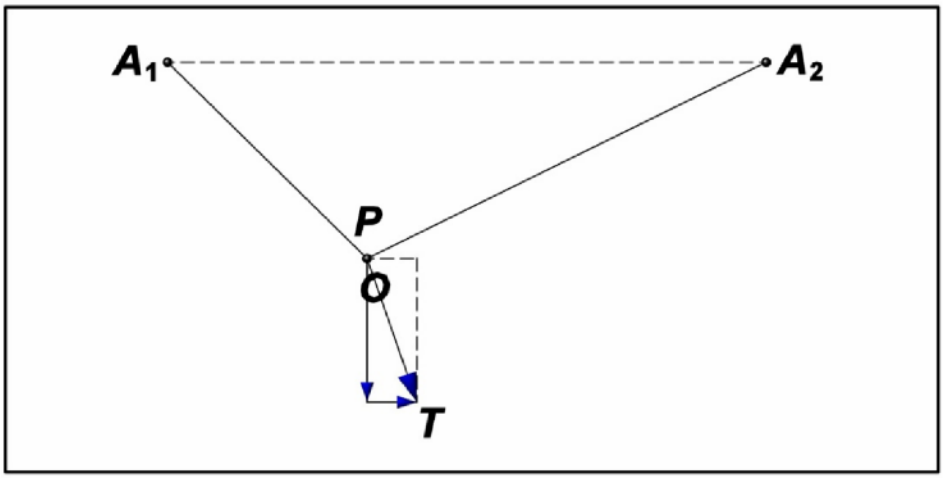

Figure 2. Vertices 1

TWO LEGGED BRIDLE LABELS

Distance Labels

The distances in a two-legged bridle use the same format as the distances in a force distribution problem with the exception that in the force distribution problem the distances are in a horizontal axis only. In the two-legged bridle the system must accommodate distances measured in two axes.

S = the horizontal distance between anchorages
D_{1H} = the horizontal distance from ***P*** to A_1
D_{2H} = the horizontal distance from ***P*** to A_2
D_{1V} = the vertical distance from ***P*** to A_1
D_{2V} = the vertical distance from ***P*** to A_2
D_V = an alternate to D_{V1} or D_{V2} - may be used if $D_{V1} = D_{V2}$
D_{1L} = the length of bridle leg one
D_{2L} = the length of bridle leg two

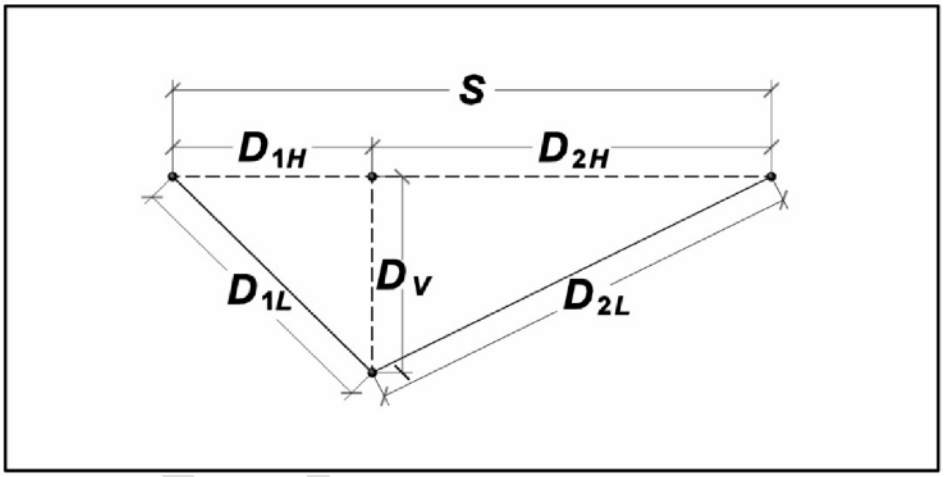

Figure 3. 2-Legged Bridle Distance Labels

Force Labels

F_A = the force (load) applied to ***P***
F_{AH} = the horizontal component of the applied force if the load is not applied vertically
F_{AV} = the vertical component of the applied force if the load is not applied vertically
F_{1H} = the horizontal force at A_1
F_{2H} = the horizontal force at A_2
F_{1V} = the vertical force at A_1
F_{2V} = the vertical force at A_2
F_{1L} = the force in leg one
F_{2L} = the force in leg two

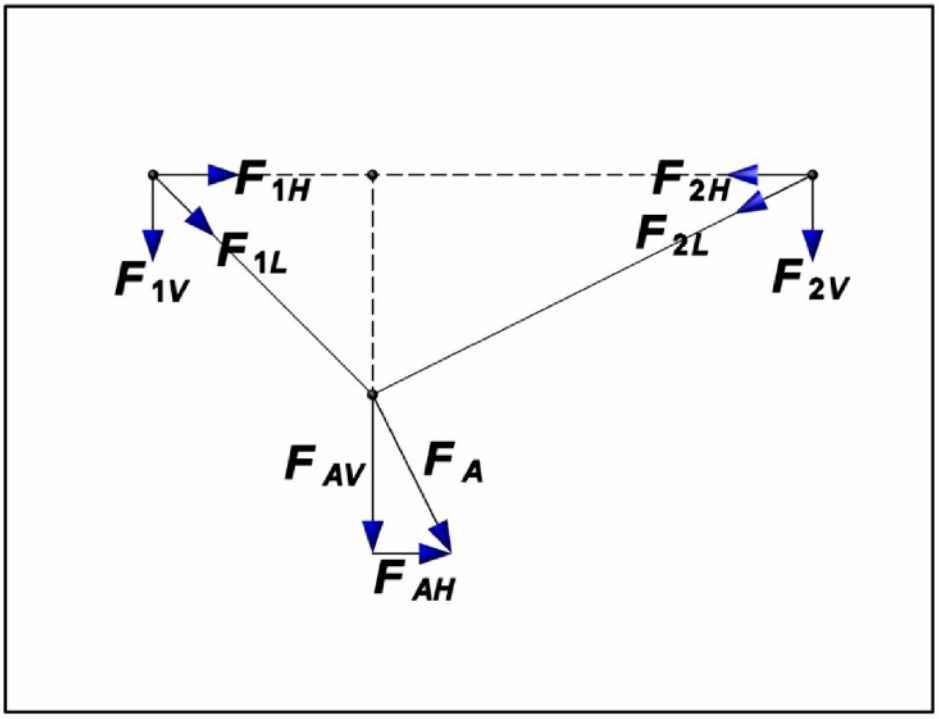

Figure 4. 2-Legged Bridle Force Labels

Angle Labels

a_1 = the acute angle between horizontal and leg one measured at ***A_1***
a_2 = the acute angle between horizontal and leg two measured at ***A_2***
p_1 = the acute angle between vertical and leg one measured at ***P***
P_2= the acute angle between vertical and leg two measured at ***P***
p = the acute or obtuse angle between leg one and leg two at the bridle point
o = the acute angle between horizontal and ***FA***, measured at ***O***
t = the acute angle between vertical and ***FA***, measured at ***T***

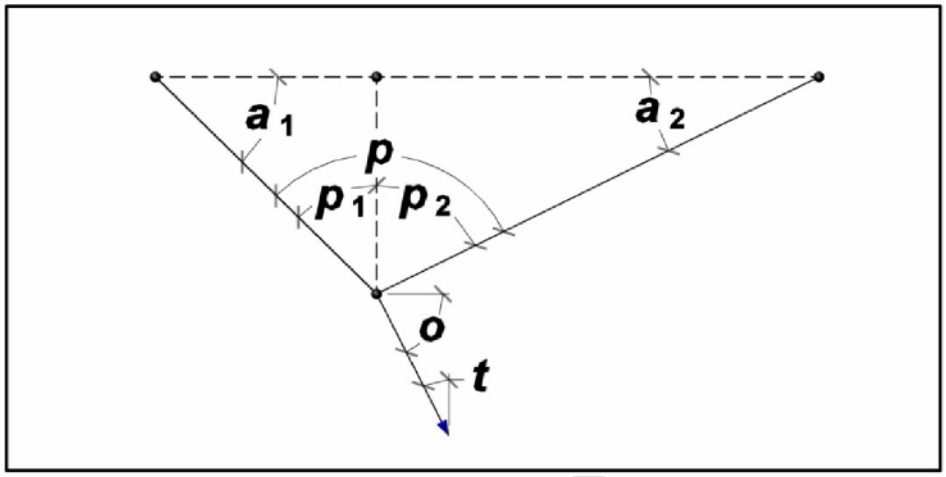

Figure 5. 2-Legged Bridle Angle Labels

THREE LEGGED BRIDLE LABELS

Three legged bridle forces and distances would follow the same pattern except that the Cartesian coordinate system subscripts would be included in lieu of ***H*** and ***V*** since the bridles can only be described in three dimensions.

Distance

D_{1L} = the length of leg one
D_{2L} = the length of leg two
D_{3L} = the length of leg three
D_{1X} = the offset in ***X*** between ***P*** and A_1
D_{2X} = the offset in ***X*** between ***P*** and A_2
D_{3X} = the offset in ***X*** between ***P*** and A_3
D_{1Y} = the offset in ***Y*** between ***P*** and A_1
D_{2Y} = the offset in ***Y*** between ***P*** and A_2
D_{3Y} = the offset in ***Y*** between ***P*** and A_3
D_{1Z} = the offset in ***Z*** between ***P*** and A_1
D_{2Z} = the offset in ***Z*** between ***P*** and A_2
D_{3Z} = the offset in ***Z*** between ***P*** and A_3
D_Z = an alternate to D_{1Z}, D_{2Z} or D_{3Z} only if $D_{1Z} = D_{2Z} = D_{3Z}$
D_{1H} = the horizontal distance from ***P*** to A_1 in line with leg one
D_{2H} = the horizontal distance from ***P*** to A_2 in line with leg two
D_{3H} = the horizontal distance from ***P*** to A_3 in line with leg three

In solving three-legged bridle geometry problems the concept of Delta (**Δ**), the absolute difference, seems to be easily explained and comprehended when given the Cartesian coordinates of the anchorages and bridle point. As an example, Δ_{1X} could be substituted for D_{1X}.

Δ_{1X} = the absolute difference in ***X*** between A_1 and ***P***
Δ_{2X} = the absolute difference in ***X*** between A_2 and ***P***
Δ_{3X} = the absolute difference in ***X*** between A_3 and ***P***
Δ_{1Y} = the absolute difference in ***Y*** between A_1 and ***P***
Δ_{2Y} = the absolute difference in ***Y*** between A_2 and ***P***
Δ_{3Y} = the absolute difference in ***Y*** between A_3 and ***P***
Δ_{1Z} = the absolute difference in ***Z*** between A_1 and ***P***
Δ_{2Z} = the absolute difference in ***Z*** between A_2 and ***P***
Δ_{3Z} = the absolute difference in ***Z*** between A_3 and ***P***
Δ_Z = an alternate to Δ_{1Z}, Δ_{2Z} or Δ_{3Z} only if $\Delta_{1Z} = \Delta_{2Z} = \Delta_{3Z}$

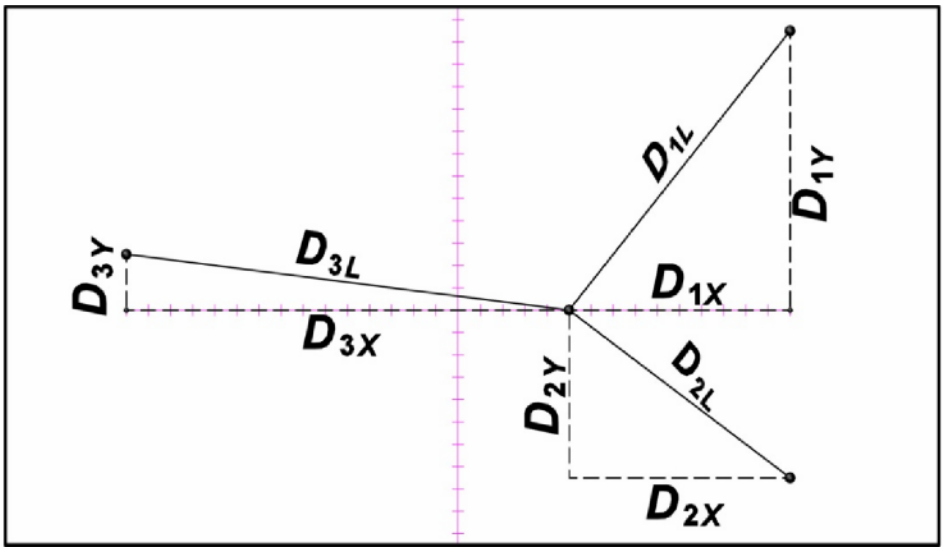

Figure 6. 3-Legged Bridle Distances – Plan View

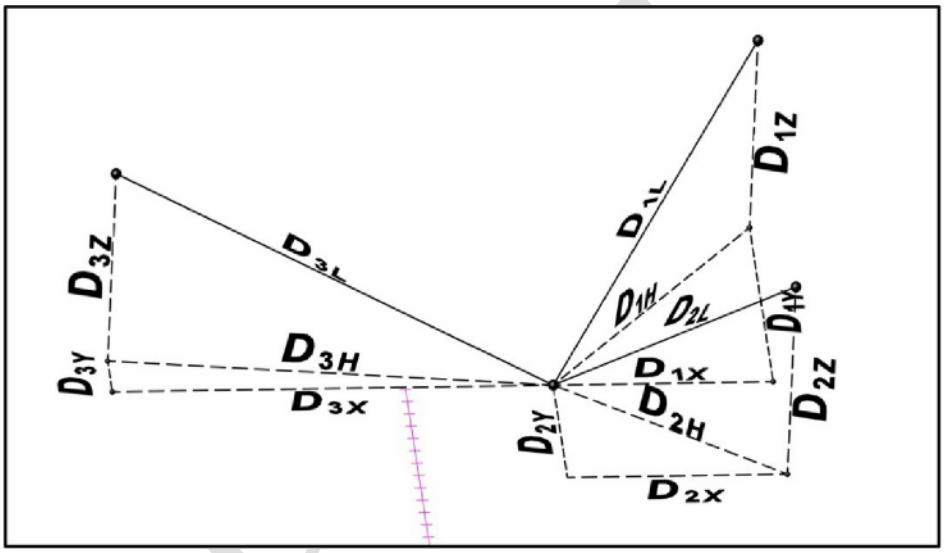

Figure 7. 3-Legged Bridle Distances – 3D View

Force

F_A = the applied force
F_{AX} = the ***X*** axis component of F_A
F_{AY}= the ***Y*** axis component of F_A
F_{AZ} = the ***Z*** axis component of F_A
F_{AH} = the horizontal component in line with F_A
F_{1L} = the force in leg one
F_{2L} = the force in leg two
F_{3L} = the force in leg three
F_{1X} = the horizontal force parallel to the ***X*** axis at A_1
F_{2X}= the horizontal force parallel to the ***X*** axis at A_2
F_{3x} = the horizontal force parallel to the ***X*** axis at A_3
F_{1Y} = the horizontal force parallel to the ***Y*** axis at A_1
F_{2Y} = the horizontal force parallel to the ***Y*** axis at A_2
F_{3Y} = the horizontal force parallel to the ***Y*** axis at A_3
F_{1Z} = the vertical force at A_1
F_{2Z} = the vertical force at A_2
F_{3Z} = the vertical force at A_3
F_{1H} = the horizontal force at A_1 in line with leg one
F_{2H} = the horizontal force at A_2 in line with leg two
F_{3H} = the horizontal force at A_3 in line with leg three

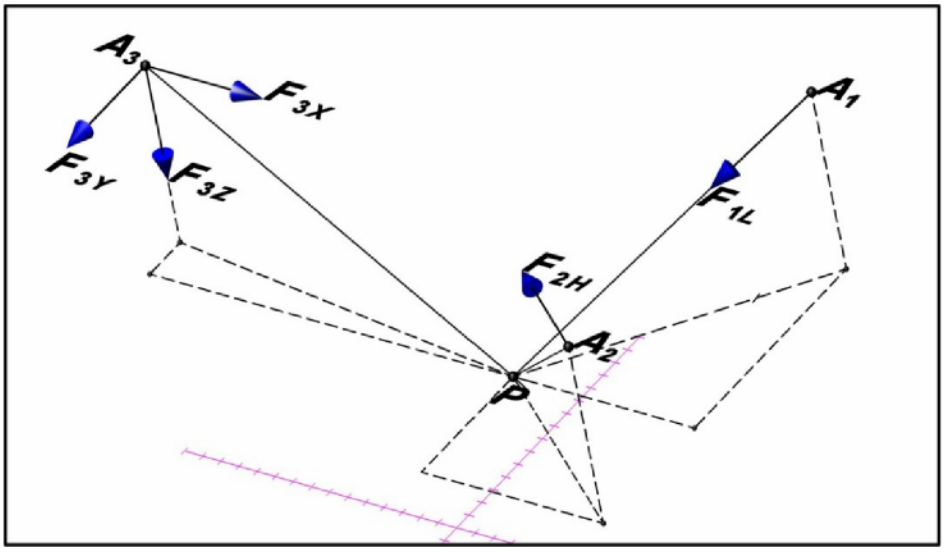

Figure 8. 3-Legged Bridle Anchorage Force Labels (Examples)

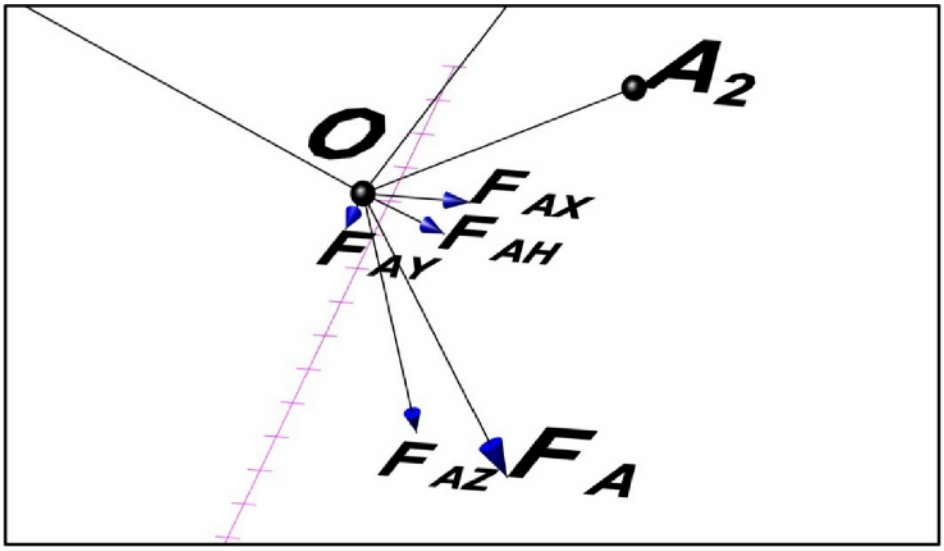

Figure 9. 3-Legged Bridle Applied Force Labels

Angle Labels

Bridle angles viewed in a horizontal plane:

α_{1r} = the angle of rotation of leg 1, measured counterclockwise from the ***X*** axis, measured at ***O***

α_{2r} = the angle of rotation of leg 2, measured counterclockwise from the ***X*** axis, measured at ***O***

α_{3r} = the angle of rotation of leg 3, measured counterclockwise from the ***X*** axis, measured at ***O***

α_{1hx} = the acute angle that measures the offset in the ***X*** axis between A_1 and ***P***, measured at its anchorage

α_{2hx} = the acute angle that measures the offset in the ***X*** axis between A_2 and ***P***, measured at its anchorage

α_{3hx} = the acute angle that measures the offset in the ***X*** axis between A_3 and ***P***, measured at its anchorage

α_{1hy} = the acute angle that measures the offset in the ***Y*** axis between A_1 and ***P***, measured at its anchorage

α_{2hy} = the acute angle that measures the offset in the ***Y*** axis between A_2 and ***P***, measured at its anchorage

α_{3hy} = the acute angle that measures the offset in the ***Y*** axis between A_3 and ***P***, measured at its anchorage

β_{1hx} = the acute angle that measures the offset in the ***X*** axis between A_1 and ***P***, measured at the bridle point

β_{2hx} = the acute angle that measures the offset in the ***X*** axis between A_2 and ***P***, measured at the bridle point

β_{3hx} = the acute angle that measures the offset in the ***X*** axis between A_3 and ***P***, measured at the bridle point

β_{1hy} = the acute angle that measures the offset in the ***Y*** axis between A_1 and ***P***, measured at the bridle point

β_{2hy} = the acute angle that measures the offset in the ***Y*** axis between A_2 and ***P***, measured at the bridle point

β_{3hy} = the acute angle that measures the offset in the ***Y*** axis between A_3 and ***P***, measured at the bridle point

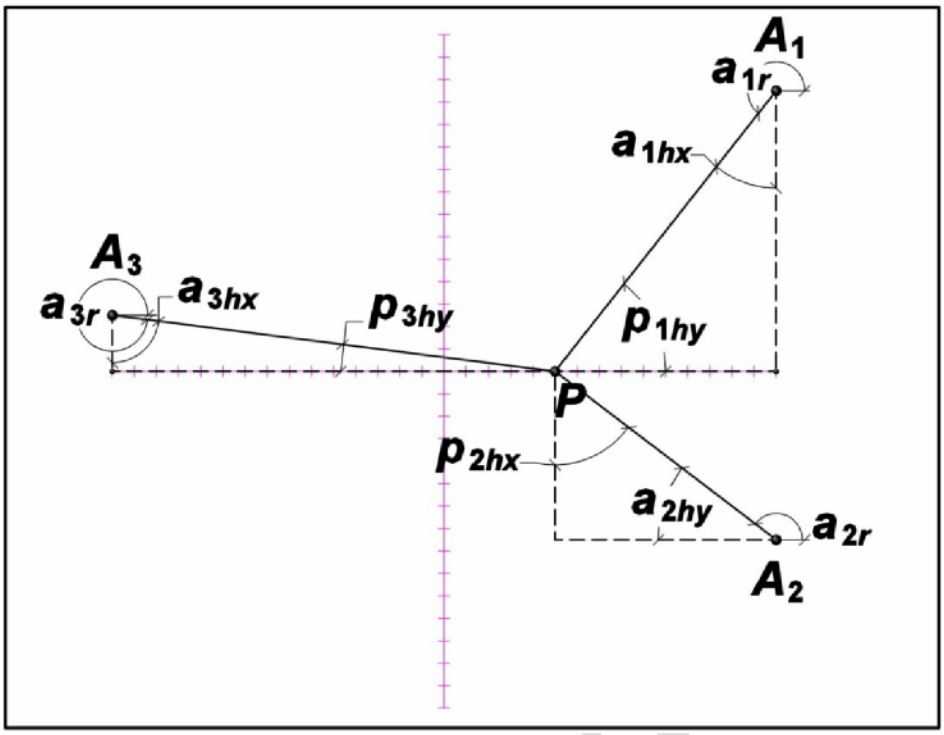

Figure 10. 3-Legged Bridle Angles Viewed in a Horizontal Plane (Examples)

Bridle angles viewed in a vertical plane, parallel to the *X* axis:
a_{1vx} = the acute angle between horizontal and leg one, measured at A_1
a_{2vx} = the acute angle between horizontal and leg two, measured at A_2
a_{3vx} = the acute angle between horizontal and leg three, measured at A_3
p_{1vx} = the acute angle between vertical and leg one, measured at P
p_{2vx} = the acute angle between vertical and leg two, measured at P
p_{3vx} = the acute angle between vertical and leg three, measured at P

Bridle angles viewed in a vertical plane, parallel to the *Y* axis:
a_{1vy} = the acute angle between horizontal and leg one, measured at A_1
a_{2vy} = the acute angle between horizontal and leg two, measured at A_2
a_{3vy} = the acute angle between horizontal and leg three, measured at A_3
p_{1vy} = the acute angle between vertical and leg one, measured at P
p_{2vy} = the acute angle between vertical and leg two, measured at P
$p3_{vy}$ = the acute angle between vertical and leg three, measured at P

Bridle angles viewed in a vertical plane, parallel to the *AP* axis:
$a1$ = the acute angle between horizontal and leg one, measured at A_1
$a2$ = the acute angle between horizontal and leg two, measured at A_2
$a3$ = the acute angle between horizontal and leg three, measured at A_3
p_1 = the acute angle between vertical and leg one, measured at P
p_2 = the acute angle between vertical and leg two, measured at P
p_3 = the acute angle between vertical and leg three, measured at P

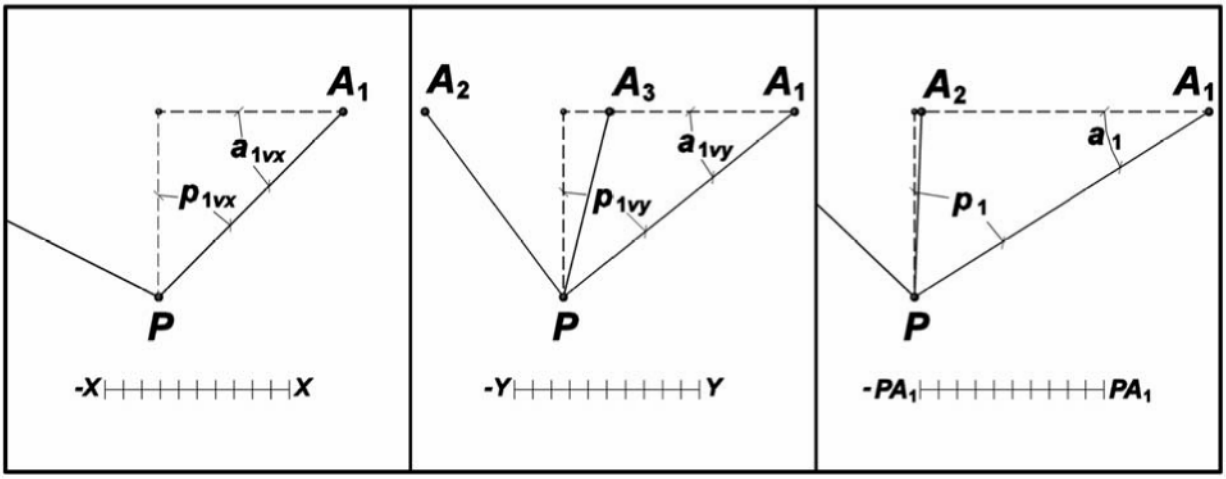

Figure 11. 3-Legged Bridle Angles Viewed in Vertical Planes

Angles associated with F_A viewed in a horizontal plane:
o_r = the angle of rotation for F_A, measured counterclockwise from the ***X*** axis, measured at ***O***
o_{hx} = the acute angle that measures the offset in ***X***, measured at ***O***
o_{hy} = the acute angle that measures the offset in ***X***, measured at ***O***
t_{hx} = the acute angle that measures the offset in ***X***, measured at ***T***
t_{hy} = the acute angle that measures the offset in ***Y***, measured at ***T***

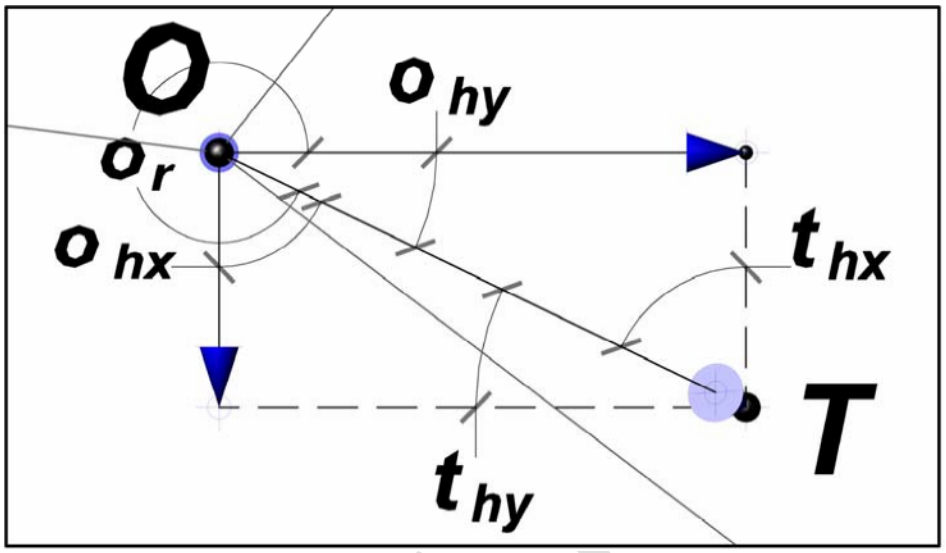

Figure 12. Applied Force Angles in a Horizontal Plane

Angles associated with F_A viewed in a vertical plane, parallel to the X axis:
o_{vx} = the acute angle between horizontal and F_A, measured at ***O***
t_{vx} = the acute angle between vertical and F_A, measured at ***T***

Angles associated with *FA* viewed in a vertical plane, parallel to the Y axis:
o_{vy} = the acute angle between horizontal and F_A, measured at ***O***
t_{vy} = the acute angle between vertical and F_A, measured at ***T***

Angles associated with *FA* viewed in a vertical plane, parallel to the OT axis:
o = the acute angle between horizontal and F_A, measured at ***O***
t = the acute angle between vertical and F_A, measured at ***O***

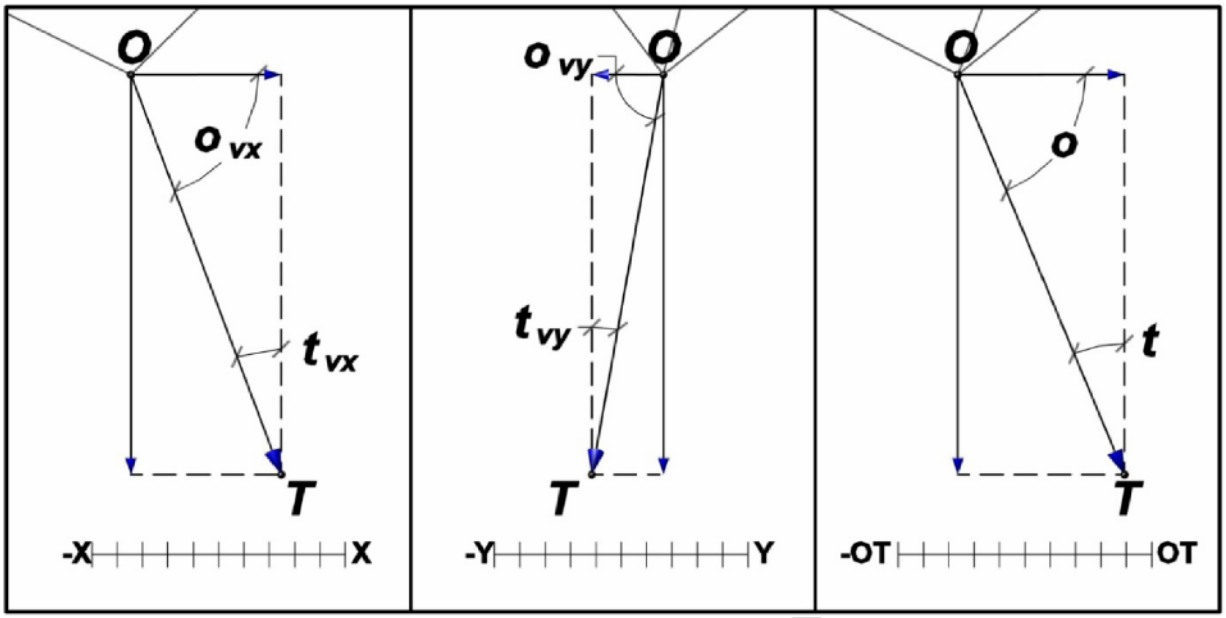

Figure 13. Applied Force Angles in Vertical Planes

Style

- Unknowns are italicized.
- The numbers are not italicized.
- Multi-letter functions are not italicized.
- Subscripts are italicized if they represent a variable or constant. If they are a descriptor, they are not. Examples: F_{L1} or F_{legone}
- "x" is never used in formulas to indicate multiplication except for explanatory purposes to non-math audiences.
- Three legged bridle legs are labeled as follows: Using the same orientation of the ***X*** and ***Y*** axis as being used for the problem, place an imaginary origin at ***P***. The legs are labeled one through three starting at the right of the junction of quadrant **IV** and **I** and increasing in a clockwise direction. If a bridle leg is in line with the quadrant **IV**-**I** dividing line, it would be leg three.
- Angles are labeled in lower case.
- The symbol **<** may be used preceding an angle but is not required. It is not to be used in a formula since it is also a symbol for *greater than*.
- The angle of rotation around the vertical axis for bridle legs are measured as follows: Place an imaginary Cartesian origin at the anchorage. Angles are measured from the bridle leg clockwise around to the positive **X** side of the **X** axis. <0-90^{o} would be in quadrant I, <90-180^{o} in Quadrant II, etc.
- The angle of rotation around the vertical axis for F_A is measured in the same fashion as bridle legs except ***O*** is used as the origin instead of ***A***.