Understanding “Position” in Welding

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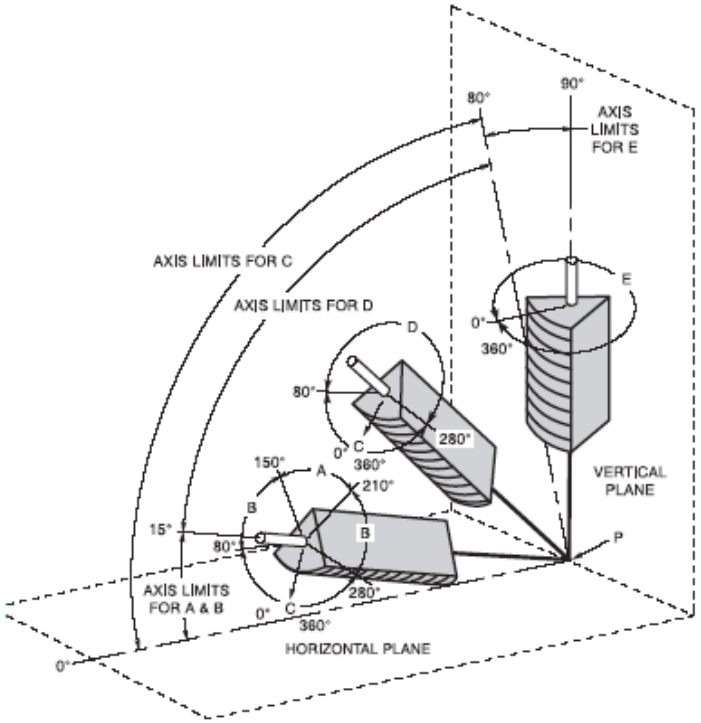
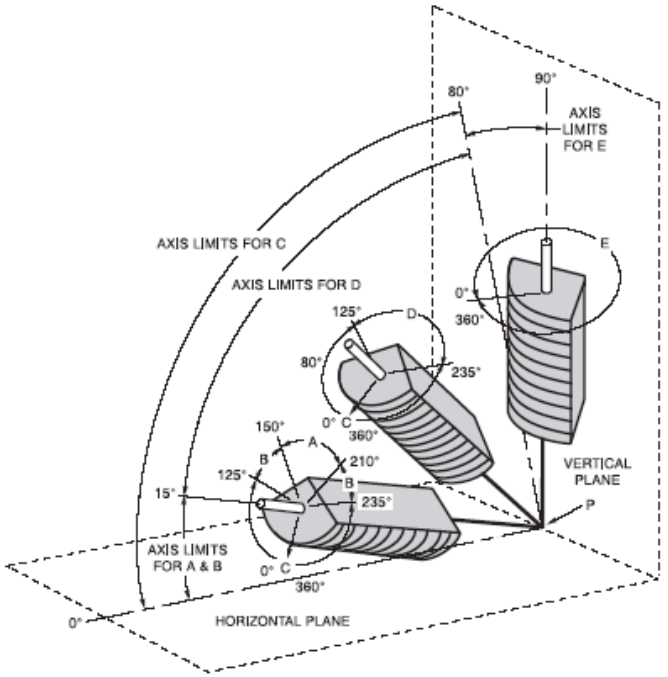
- The primary purpose of this presentation is twofold:
  - Make sure that code users understand the difference between testing positions and production welding positions
  - Help users understand how to read the figures that define production welding positions shown on the next page.

Production Welding Positions

Groove Welds

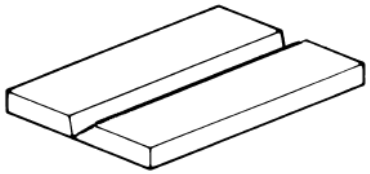


Fillet Welds

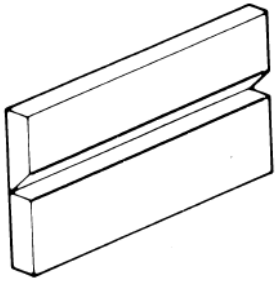


Standard Test Positions

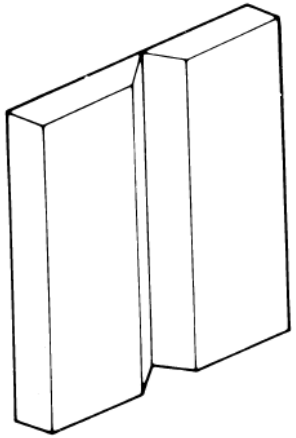
Figure QW-461.3
Groove Welds in Plate — Test Positions



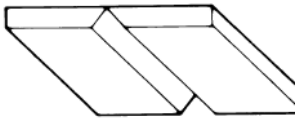
(a) 1G



(b) 2G



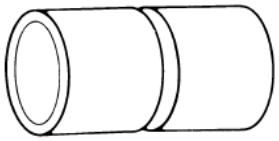
(c) 3G



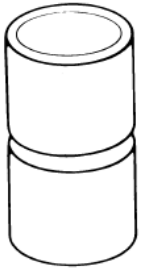
(d) 4G

Standard Test Positions

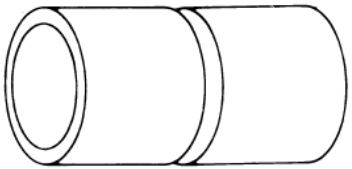
Figure QW-461.4
Groove Welds in Pipe — Test Positions



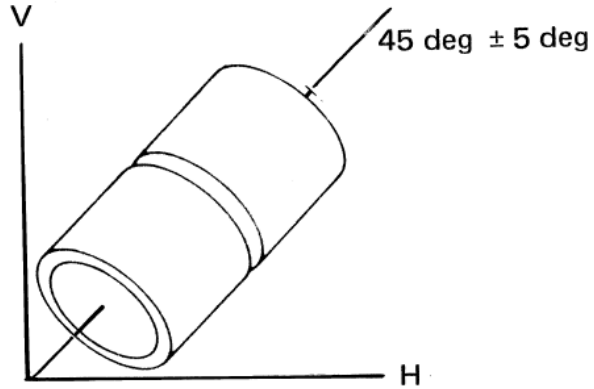
(a) 1G (Rotated)



(b) 2G



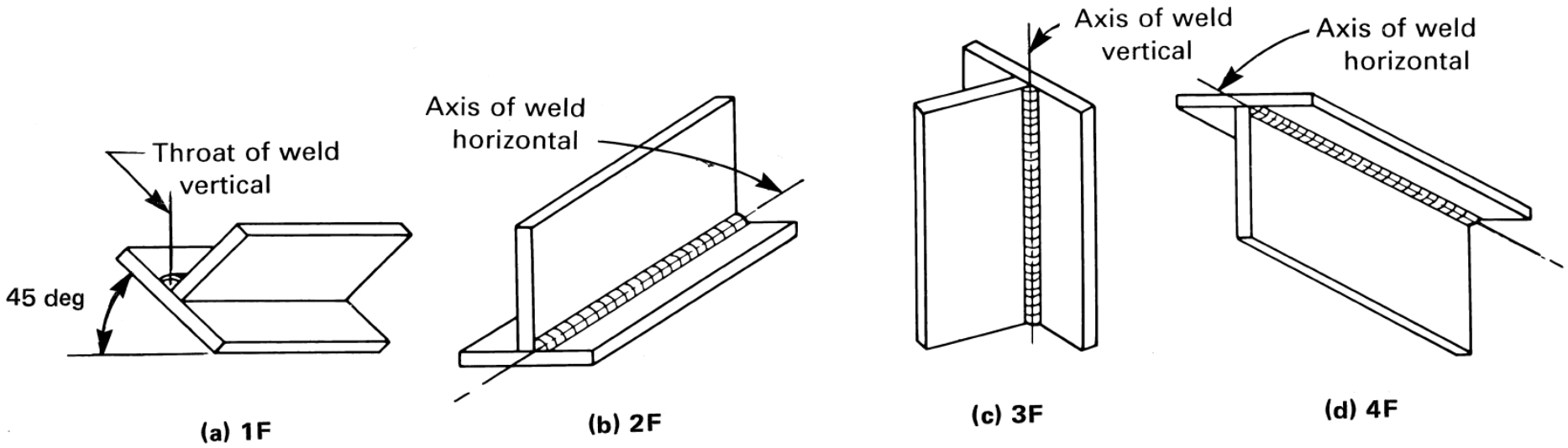
(c) 5G



(d) 6G

Standard Test Positions

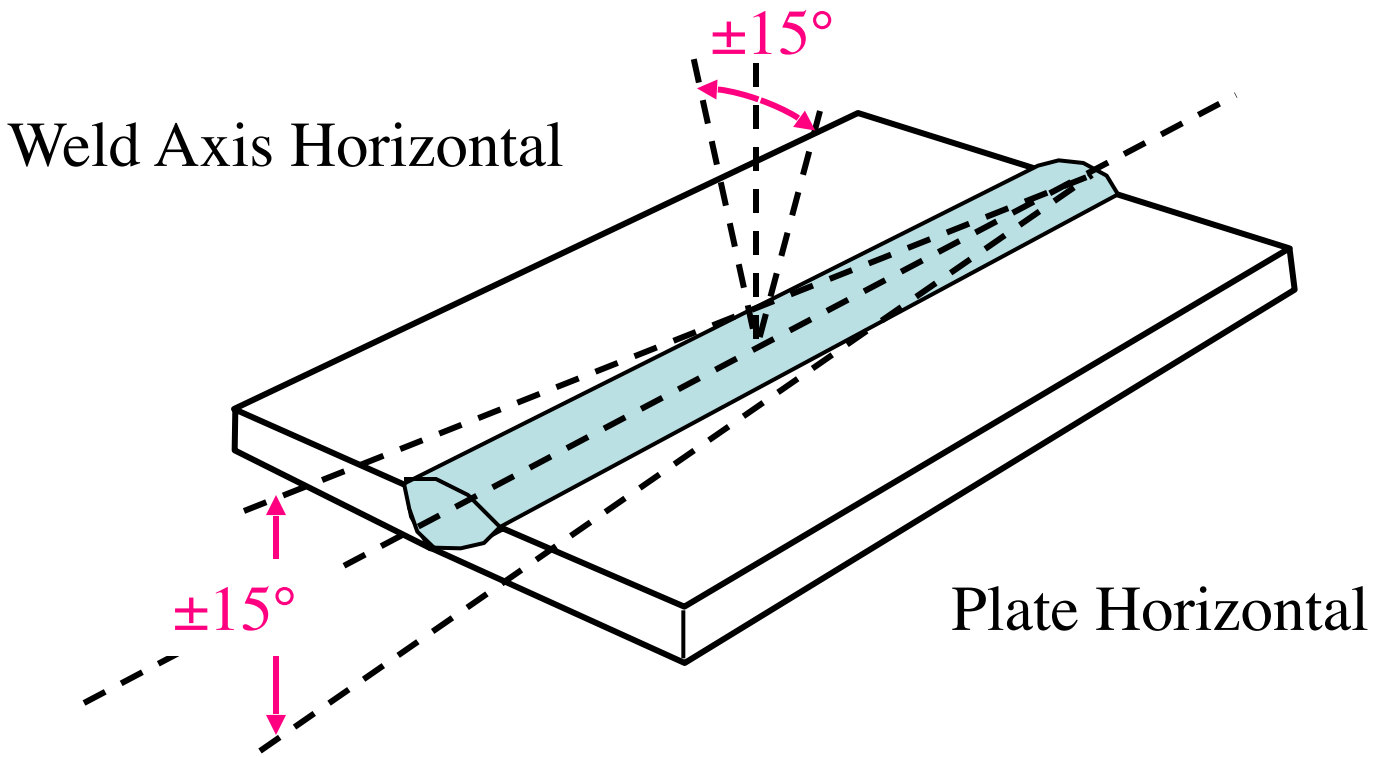
Figure QW-461.5
Fillet Welds in Plate — Test Positions



Standard Testing Positions

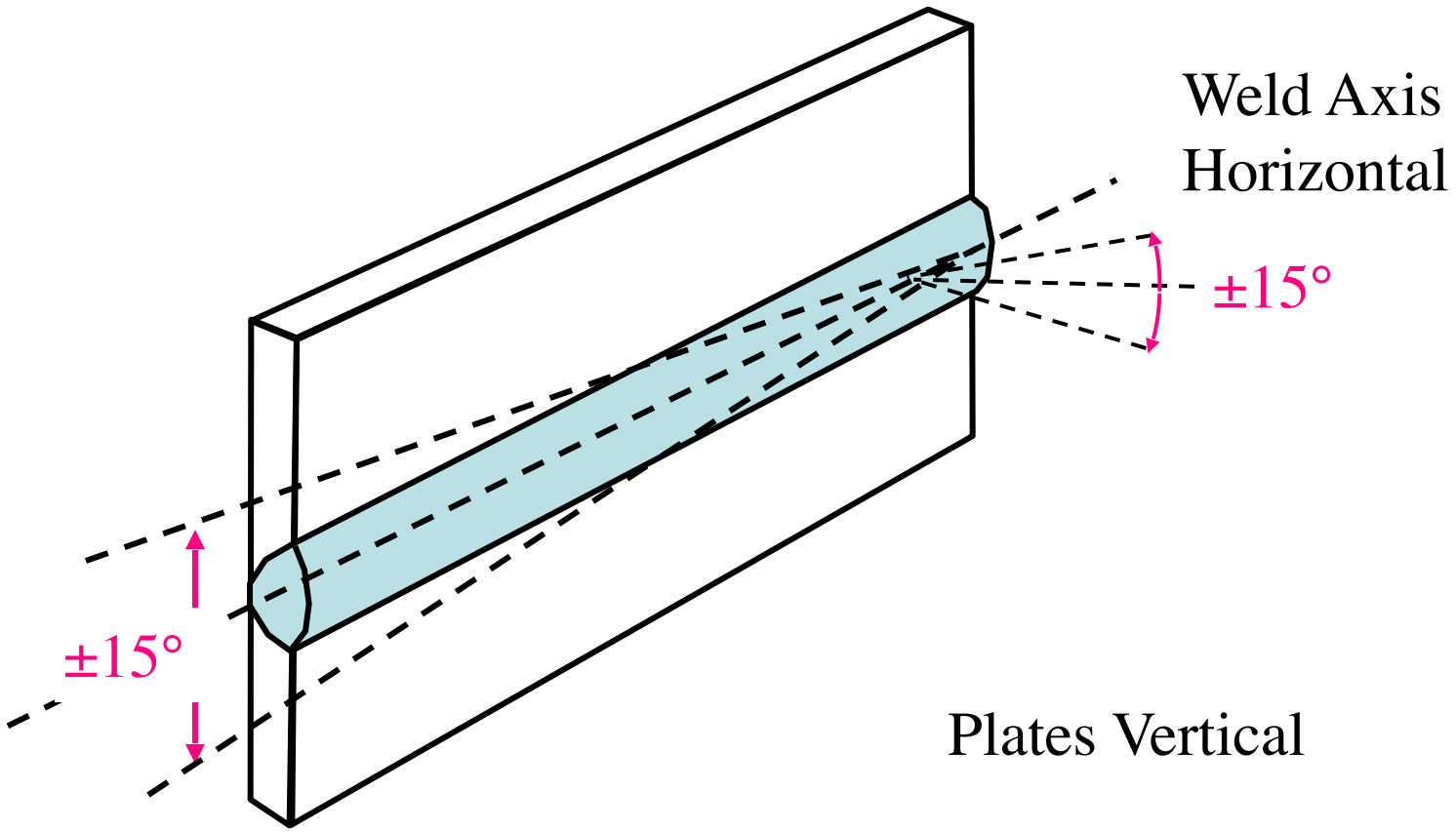
Test positions are discreetly defined positions of test coupons that are used when mostly when testing welders. These positions have tolerance of ±15° from the defined horizontal planes and ±5° from a defined vertical or inclined plane. See QW-120

Testing Position 1G/PA

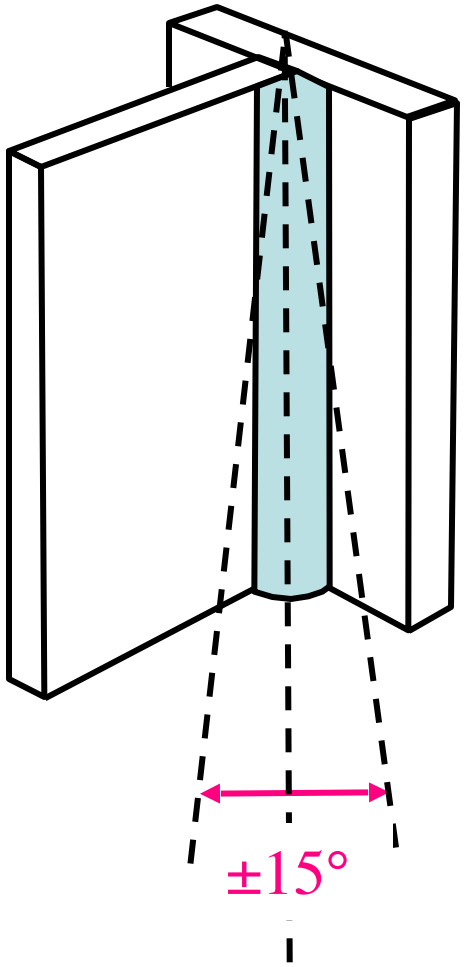


Designations PA, PB, PD, etc. are the comparable
ISO 6947 equivalent posotioons

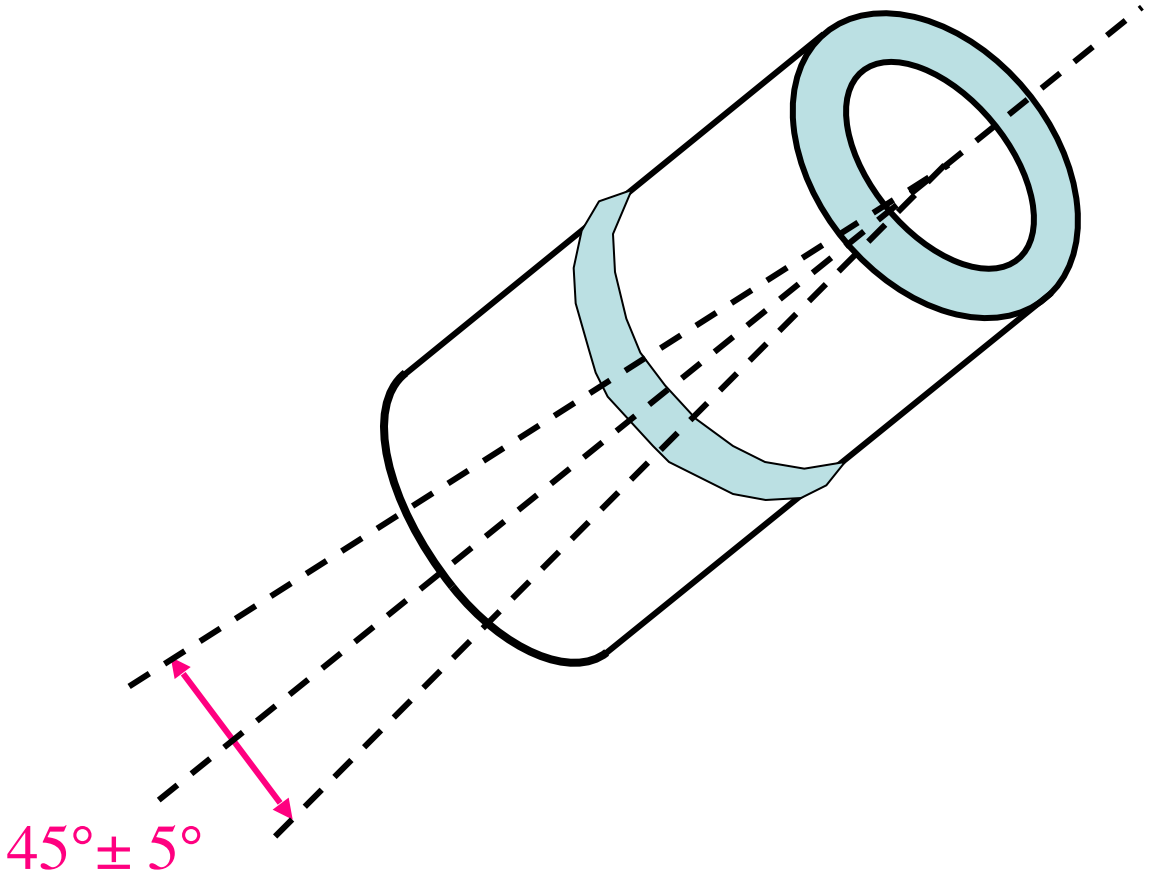
Test Position 2G/PC



Test Position 3F/PF or PG



Test Position 6G/HL045 or JL045



Test Positions are Discreetly Defined

- Because of tolerance limits on test positions, positions in between test positions are undefined!
- That is, a weld that is inclined 22° uphill and rotated 36° about its axis has no “G” or “F” position. Such a position, however, may be encountered during production welding.
- Production welding positions, therefore, need to be defined contiguously.

Test Positions Qualify Welders for Specific Welding Positions

Test Positions ➔ Welding Positions

Translations from test positions to welding positions are made in the construction codes. QW-461.9 is typical.

Test Positions ➔ Welding Positions

Qualification Test		Position and Type Weld Qualified [Note (1)]		
		Groove		Fillet
Weld	Position	Plate and Pipe Over 24 in. (610 mm) O.D.	Pipe ≤ 24 in. (610 mm) O.D.	Plate and Pipe
Plate — Groove	1G	F	F [Note (2)]	F
	2G	F,H	F,H [Note (2)]	F,H
	3G	F,V	F [Note (2)]	F,H,V
	4G	F,O	F [Note (2)]	F,H,O
	3G and 4G	F,V,O	F [Note (2)]	All
	2G, 3G, and 4G	All	F,H [Note (2)]	All
	Special Positions (SP)	SP,F	SP,F	SP,F
Plate — Fillet	1F	. . .	. . .	F [Note (2)]
	2F	. . .	. . .	F,H [Note (2)]
	3F	. . .	. . .	F,H,V [Note (2)]
	4F	. . .	. . .	F,H,O [Note (2)]
	3F and 4F	. . .	. . .	All [Note (2)]
	Special Positions (SP)	. . .	. . .	SP,F [Note (2)]
Pipe — Groove [Note (3)]	1G	F	F	F
	2G	F,H	F,H	F,H
	5G	F,V,O	F,V,O	All
	6G	All	All	All
	2G and 5G	All	All	All
	Special Positions (SP)	SP,F	SP,F	SP,F
Pipe — Fillet [Note (3)]	1F	. . .	. . .	F
	2F	. . .	. . .	F,H
	2FR	. . .	. . .	F,H
	4F	. . .	. . .	F,H,O
	5F	. . .	. . .	All
	Special Positions (SP)	. . .	. . .	SP,F

Welding Positions

Note to table:

(1) Positions of welding as shown in QW-461.1 and QW-461.2

F = Flat

H = Horizontal

V = Vertical

O = Overhead

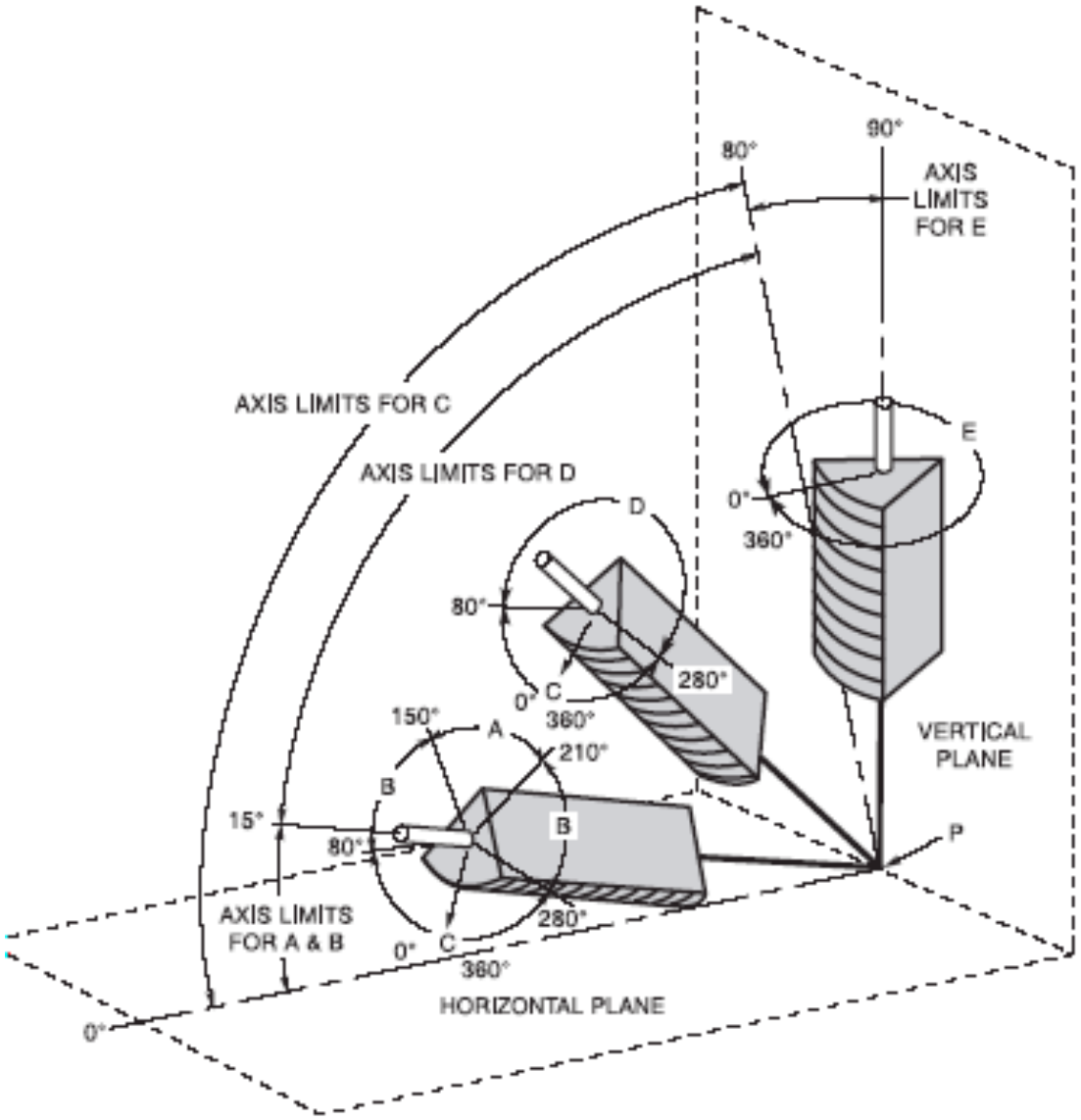
(2) Pipe 2-7/8 in outside diameter and over.

Welding positions for groove welds are defined by the following diagram.

NOTE

Welding Position Diagrams are ***contiguous***.

Welding Positions for Groove Welds



Tabulation showing transition points between welding positions

Tabulation of Positions of Groove Welds

Position	Diagram Reference	Inclination of Axis	Rotation of Face
Flat	A	0 to 15°	150 to 210°
Horizontal	B	0 to 15°	80 to 150°
			210 to 280°
Overhead	C	0 to 80°	0 to 80°
			210 to 360°
Vertical	D	15 to 80°	80 to 280°
	E	80 to 90°	0 to 360°

How this table and the diagram on the previous page work are shown in the following diagrams

Let’s start with the
Flat Position

Welding Positions

Tabulation of Positions of Groove Welds

Position	Diagram Reference	Inclination of Axis	Rotation of Face
Flat	**A**	**0 to 15°**	150 to 210°
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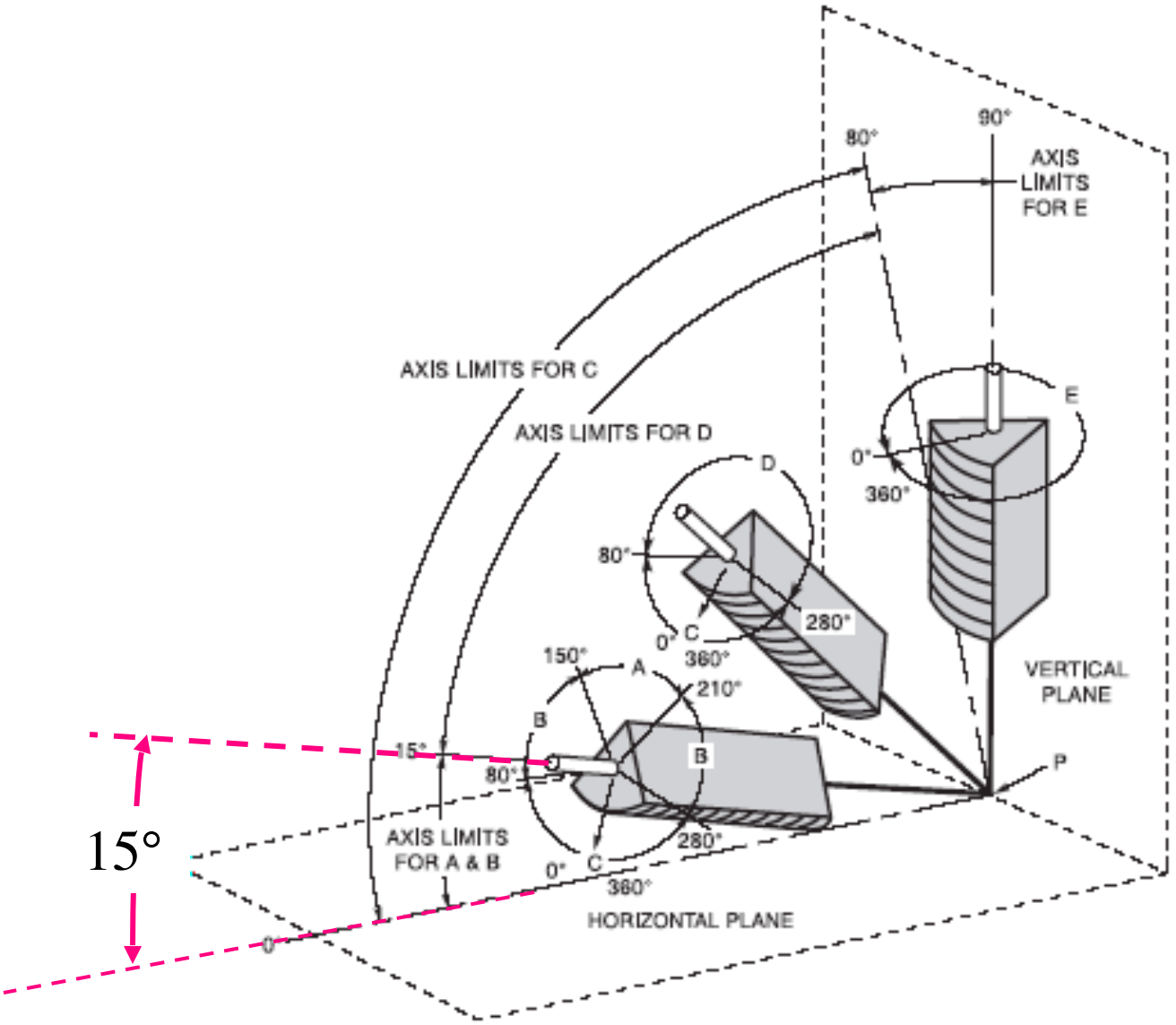
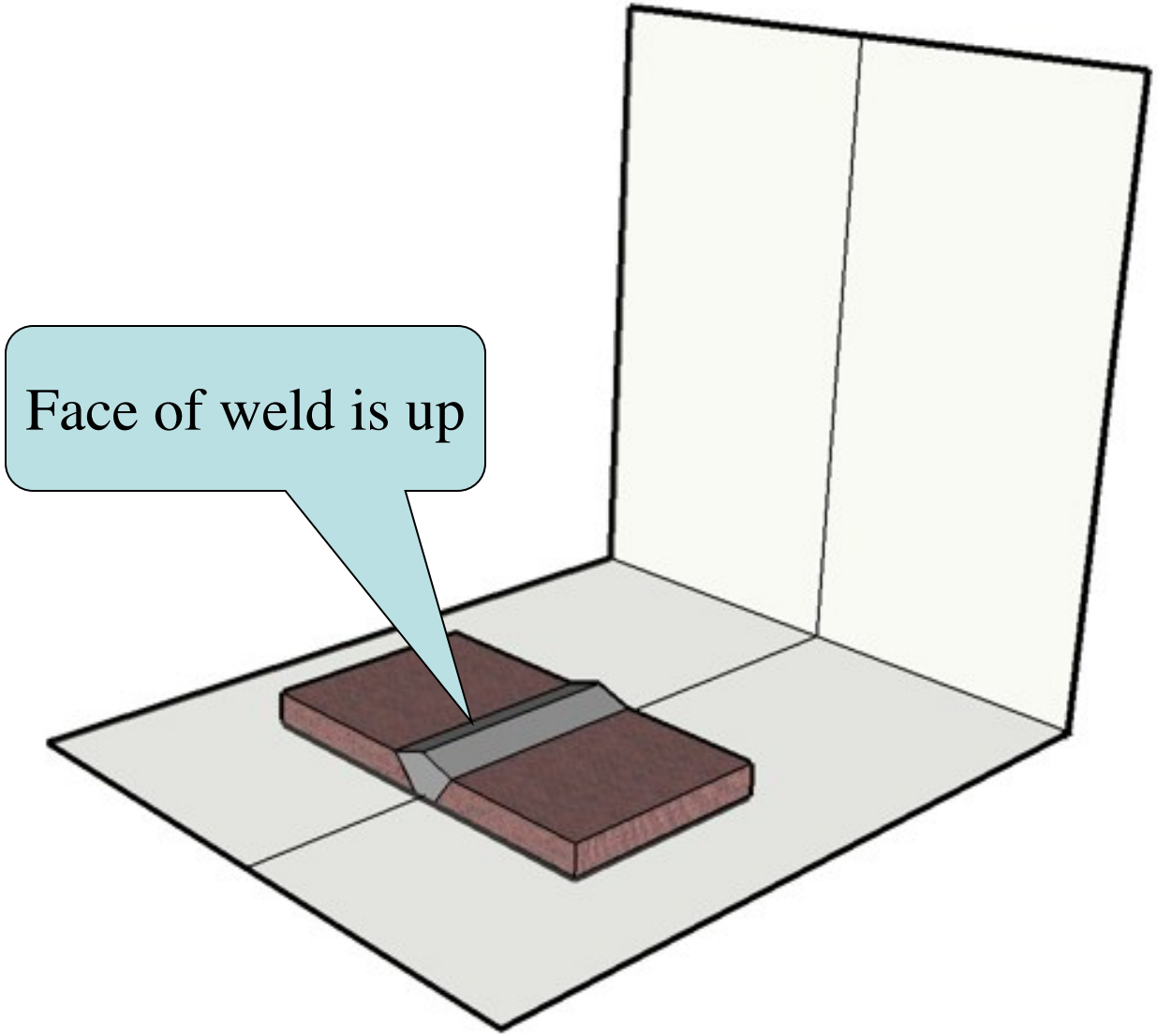
			210 to 280°
Overhead	C	0 to 80°	0 to 80°
			210 to 360°
Vertical	D	15 to 80°	80 to 280°
	E	80 to 90°	0 to 360°

How this table and the diagram on the previous page work are shown in the following diagrams

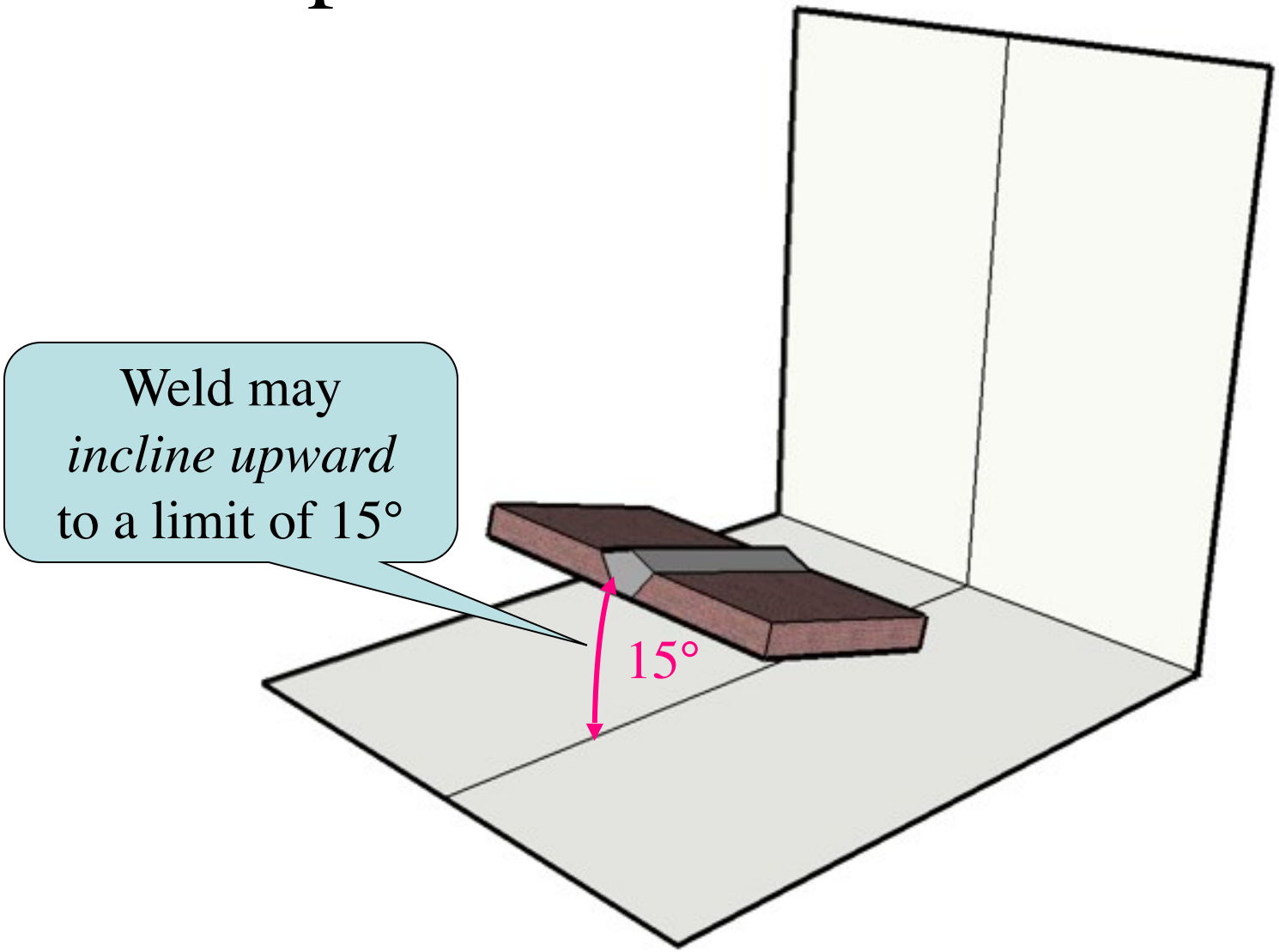
Flat Positions Axis Inclination



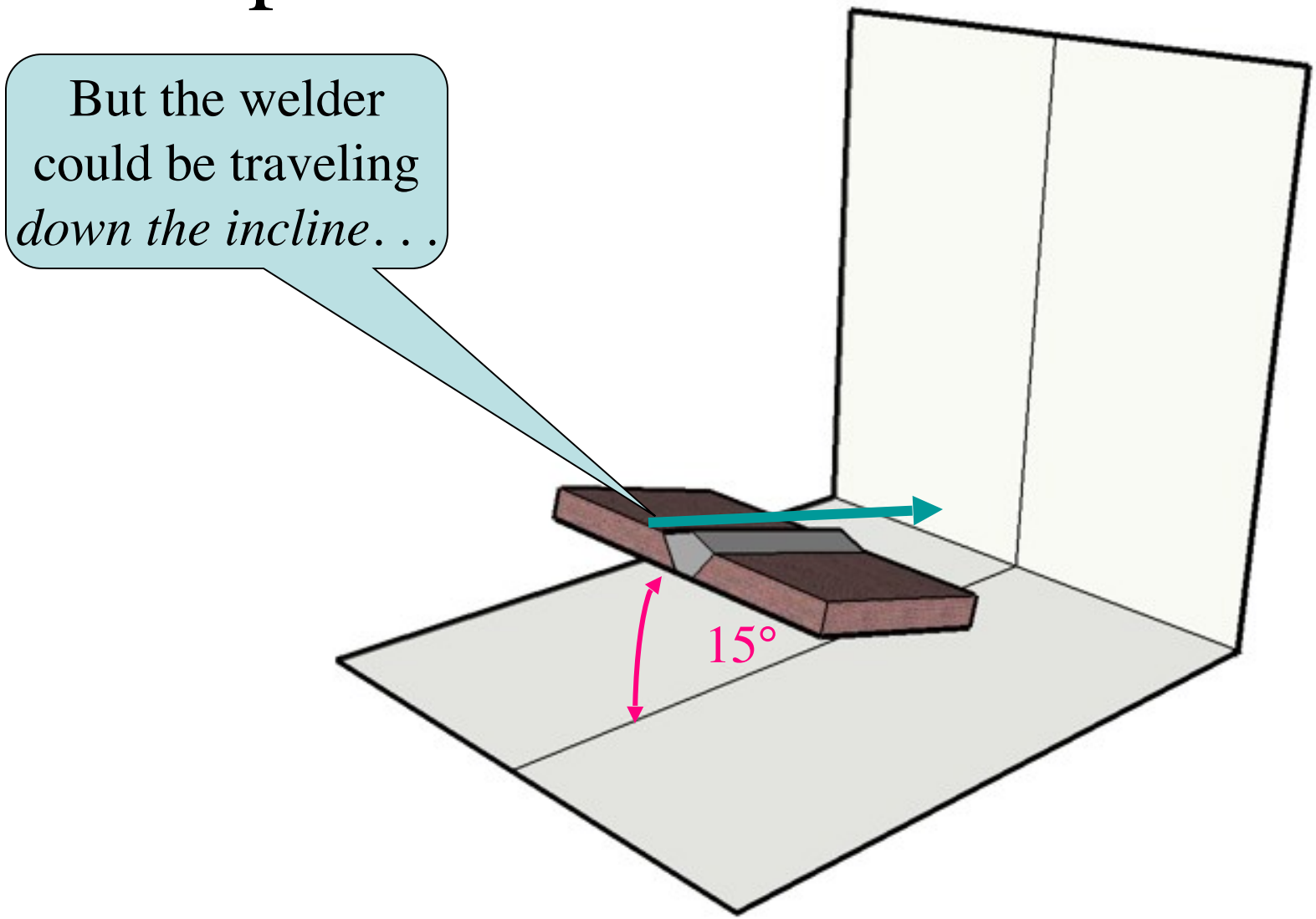
Start at Nominal Flat Position



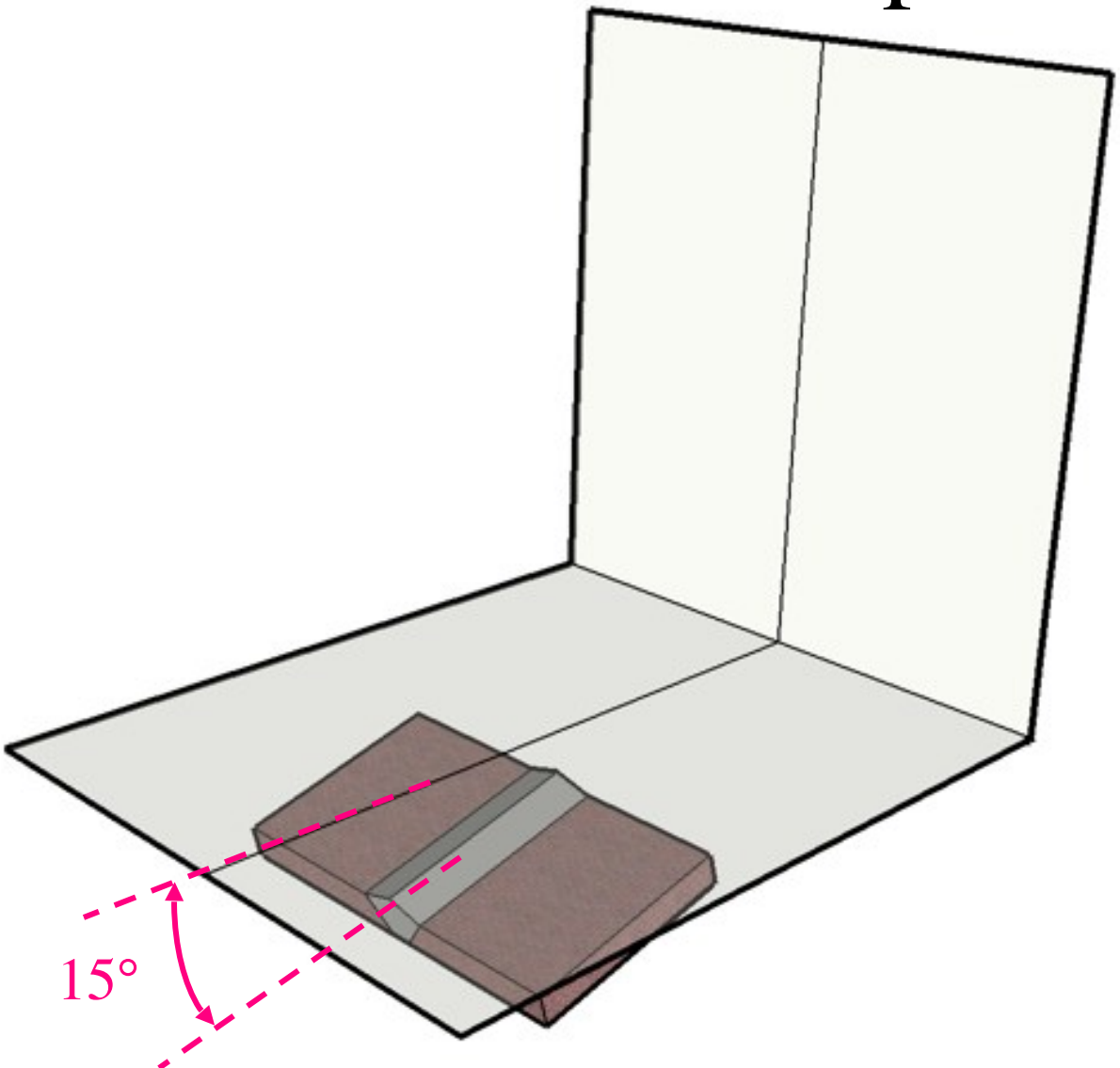
Flat Upward Inclined Limit



Flat Upward Inclined Limit



Flat *Downward* Limit Is Implied



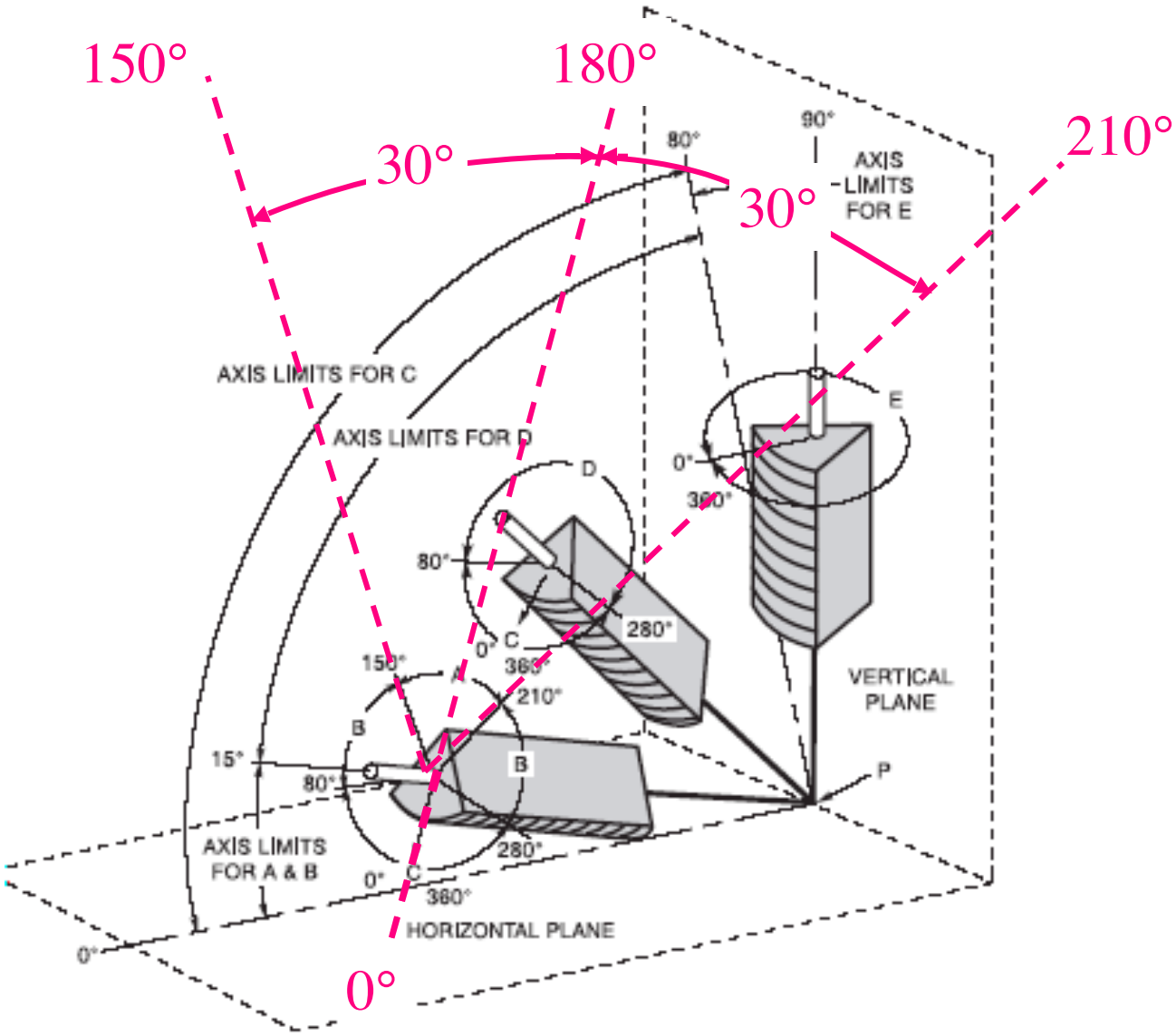
Welding Positions

Tabulation of Positions of Groove Welds

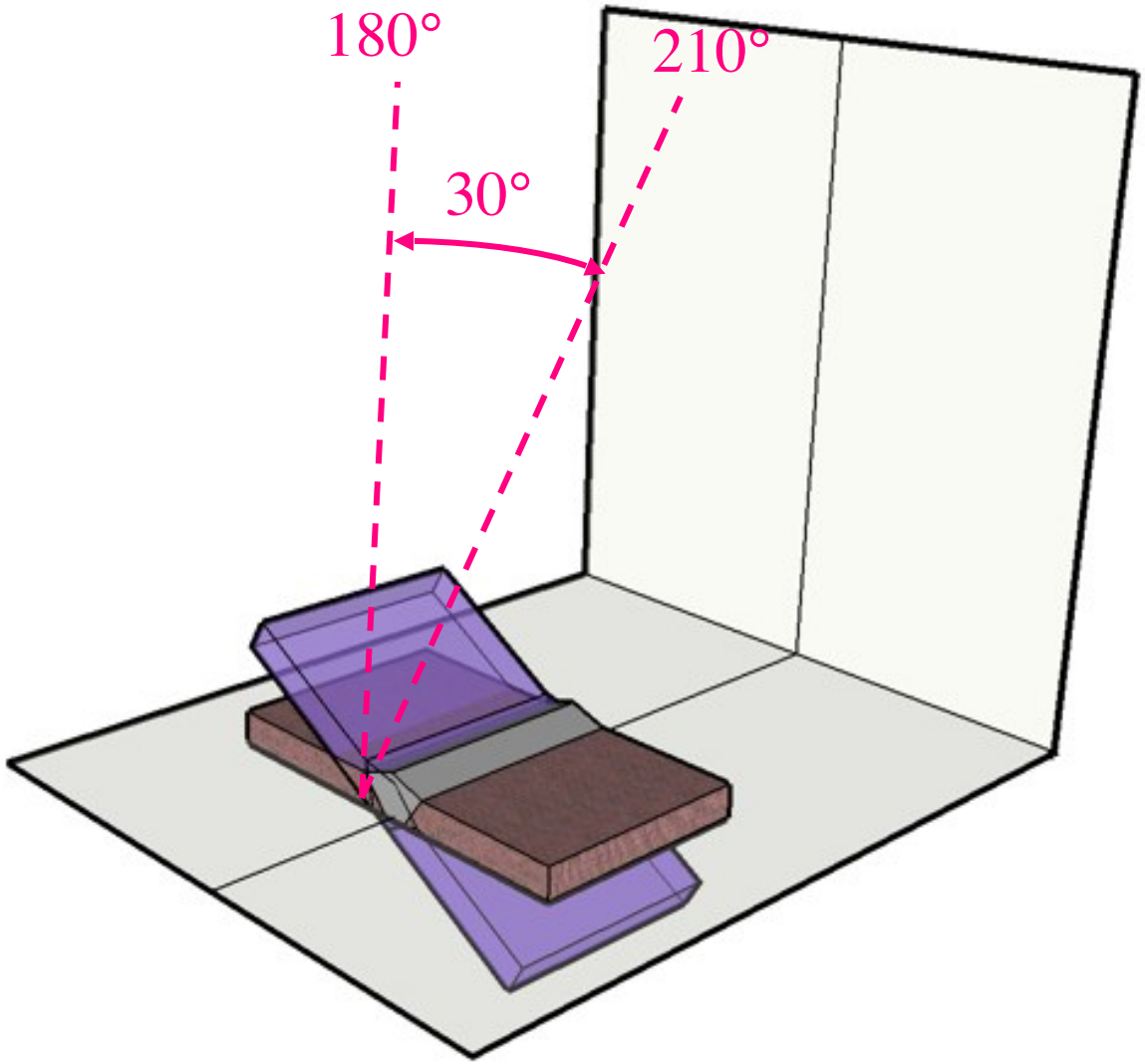
Position	Diagram Reference	Inclination of Axis	Rotation of Face
Flat	A	0 to 15°	**150 to 210°**
Horizonta	B	0 to 15°	80 to 150°
			210 to 280°
Overhead	C	0 to 80°	0 to 80°
			210 to 360°
Vertical	D	15 to 80°	80 to 280°
	E	80 to 90°	0 to 360°

How this table and the diagram on the previous page work are shown in the following diagrams

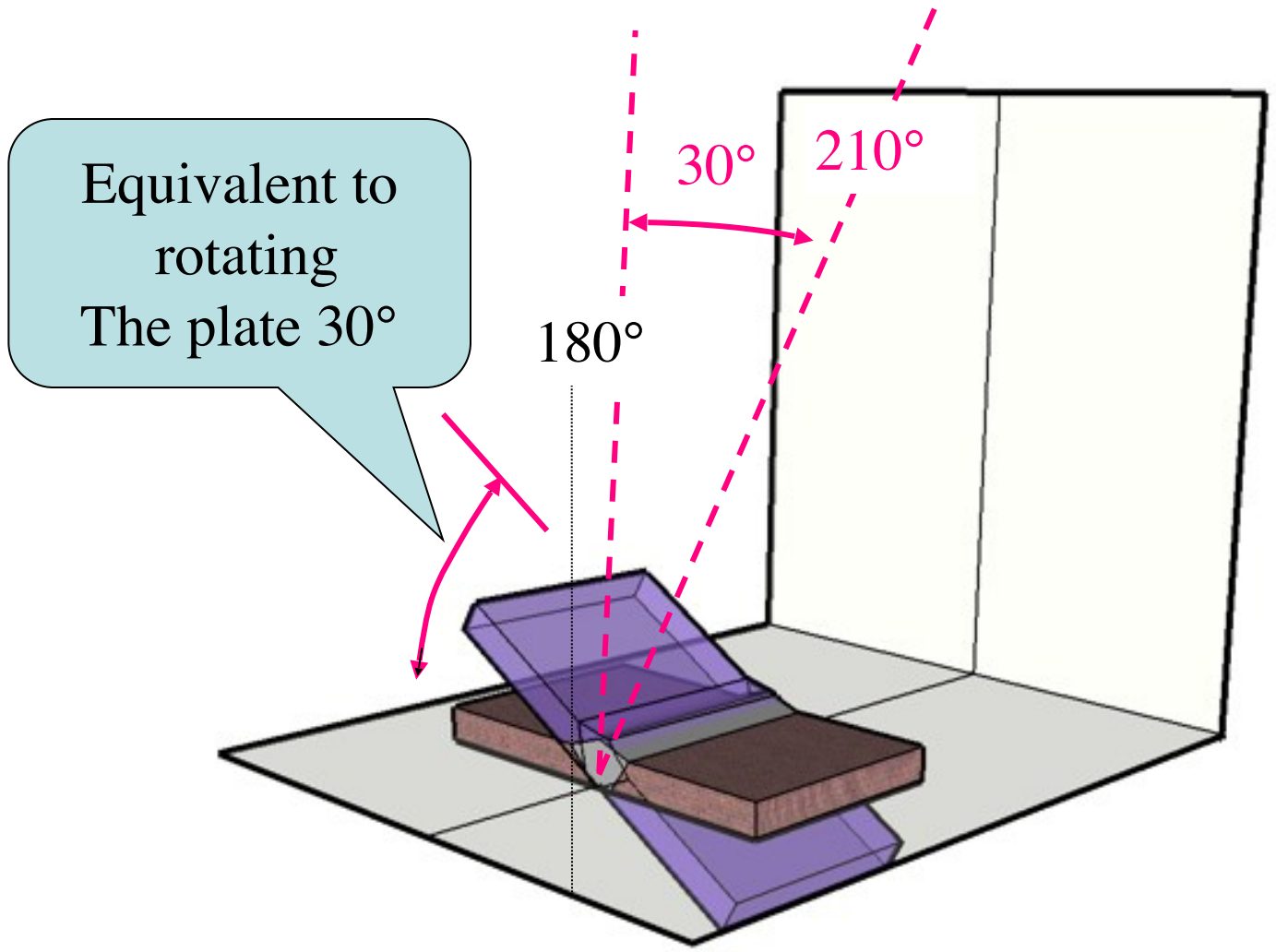
Flat Position --Rotation About Axis



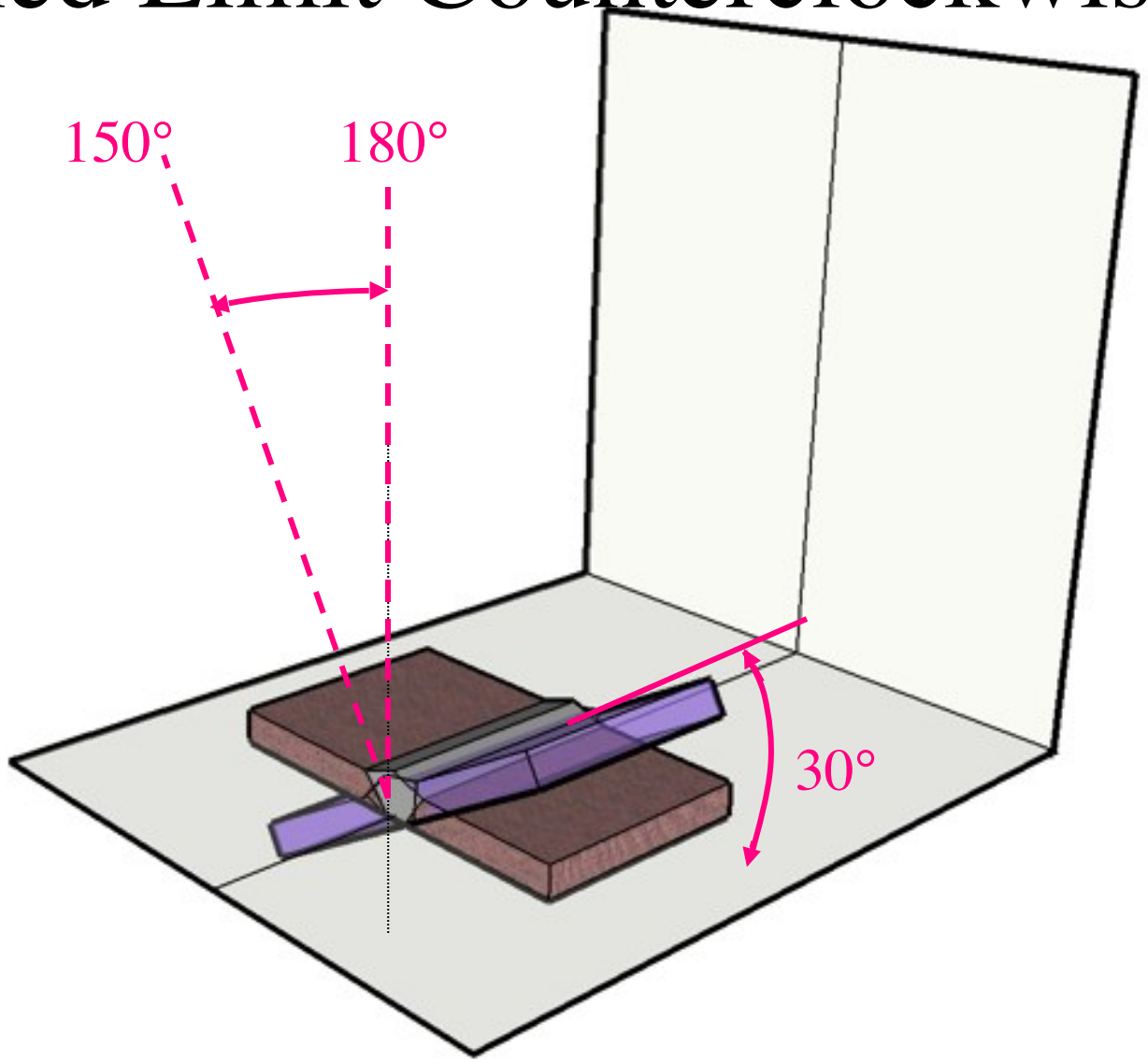
Flat Rolled Limit Clockwise



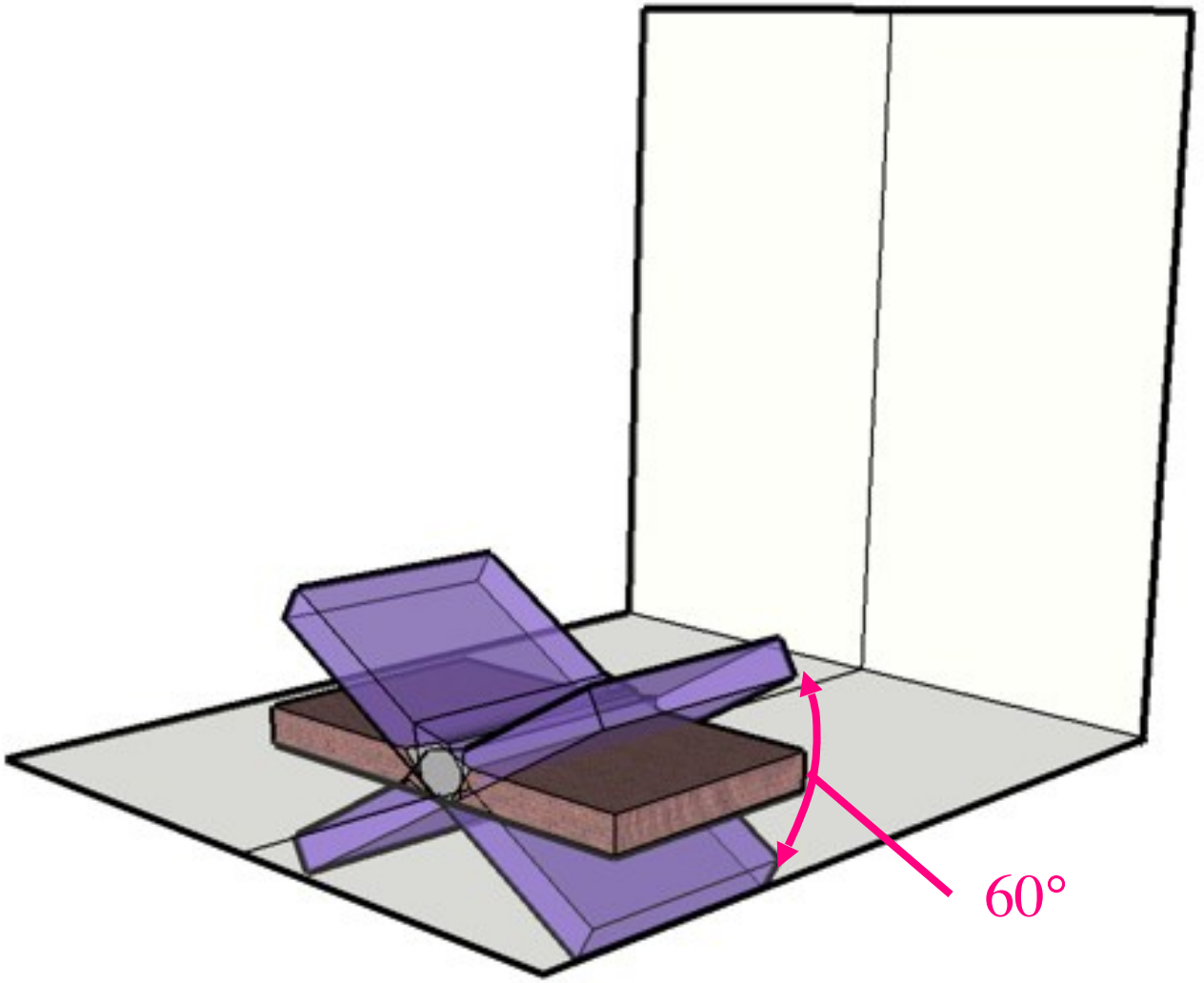
Flat Rolled Limit Clockwise



Flat Rolled Limit Counterclockwise



Flat Rotated Limits Not Considering Inclination



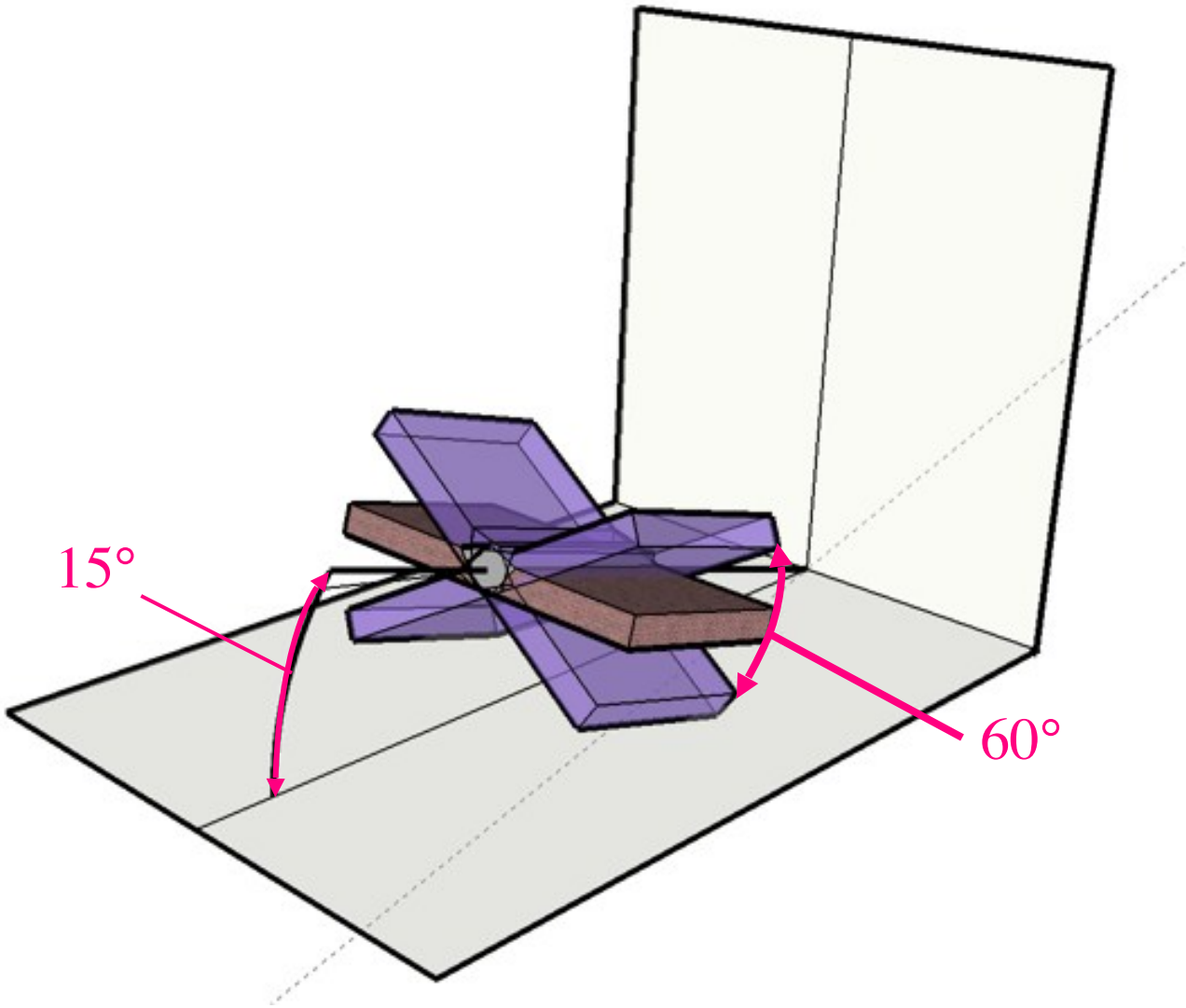
Welding Positions

Tabulation of Positions of Groove Welds

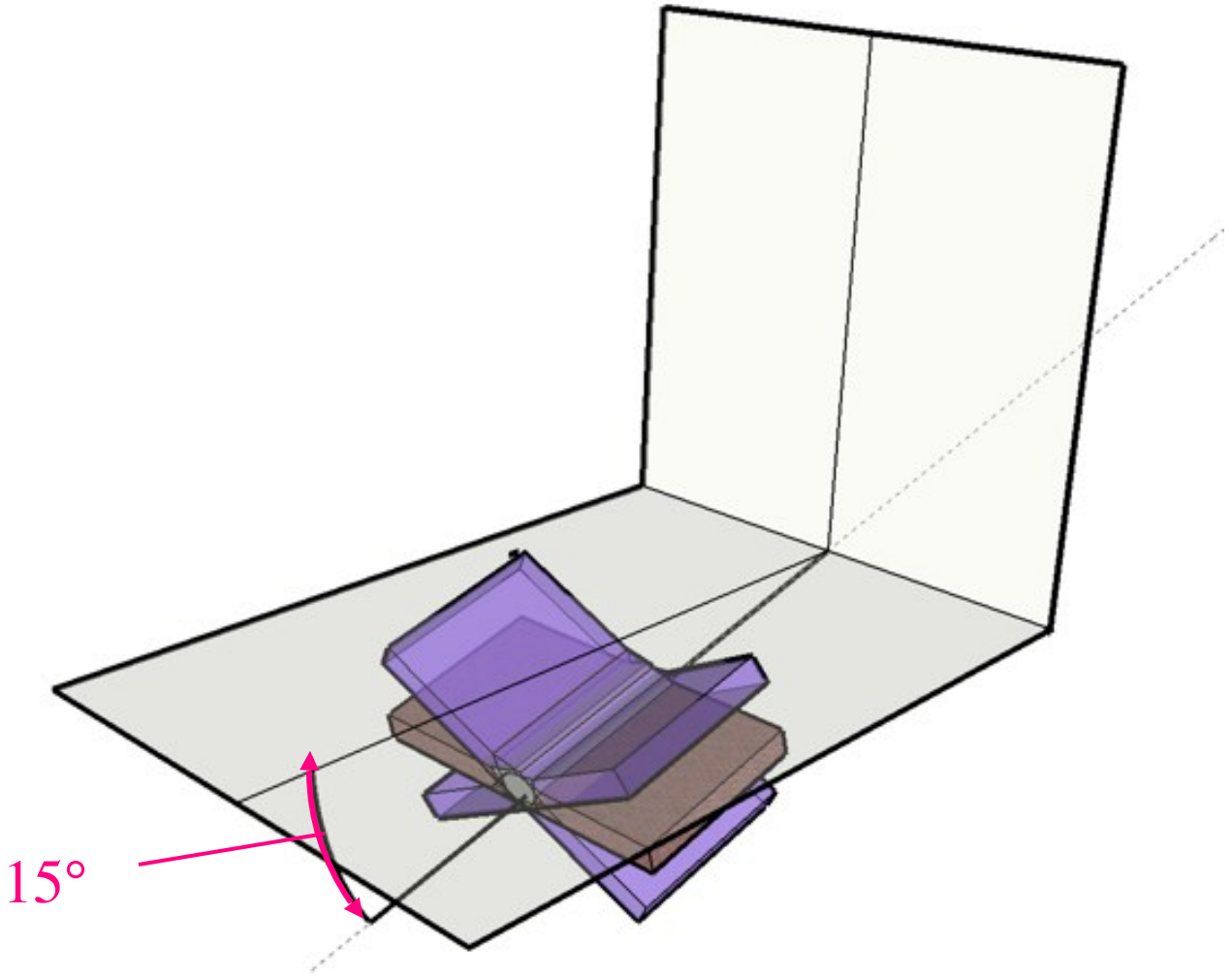
Position	Diagram Reference	Inclination of Axis	Rotation of Face
Flat	A	**0 to 15°**	**150 to 210°**
Horizonta	B	0 to 15°	80 to 150°
			210 to 280°
Overhead	C	0 to 80°	0 to 80°
			210 to 360°
Vertical	D	15 to 80°	80 to 280°
	E	80 to 90°	0 to 360°

How this table and the diagram on the previous page work are shown in the following diagrams

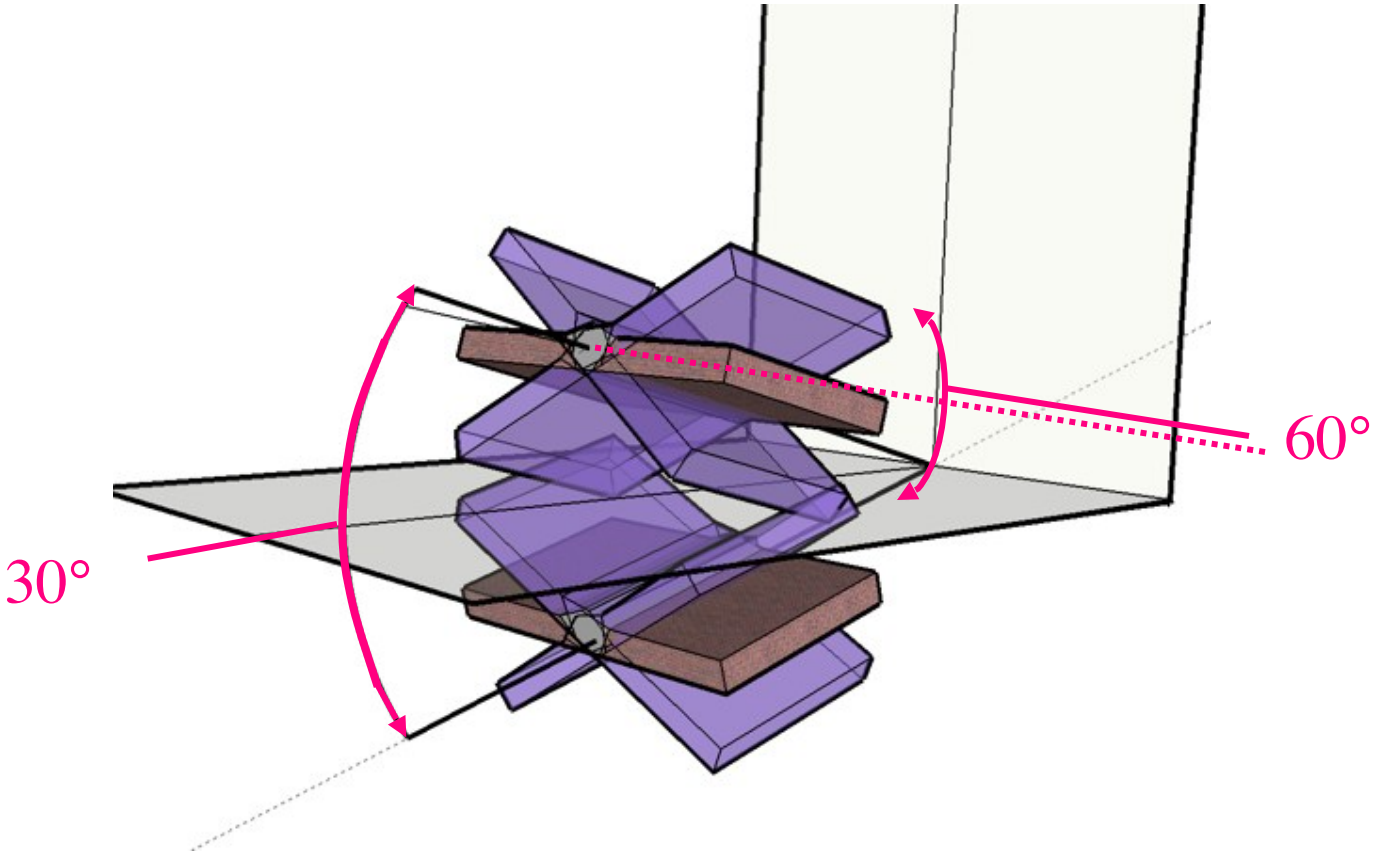
Flat Uphill Limit Rotated



Flat Downhill Limit Rotated

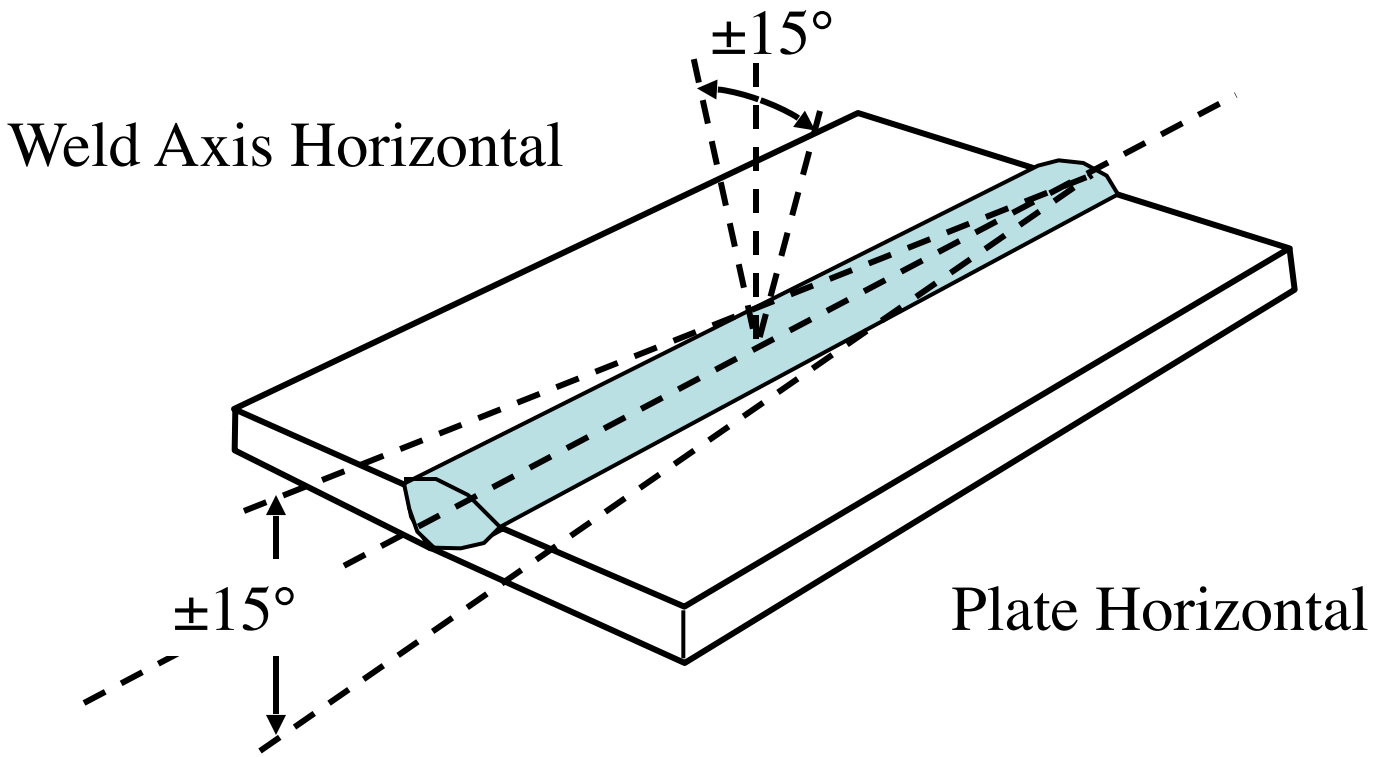


Composite Flat Position Ranges



Compare this range to 1G. . .

Testing Position 1G/PA



Flat ≠ 1G !!!!

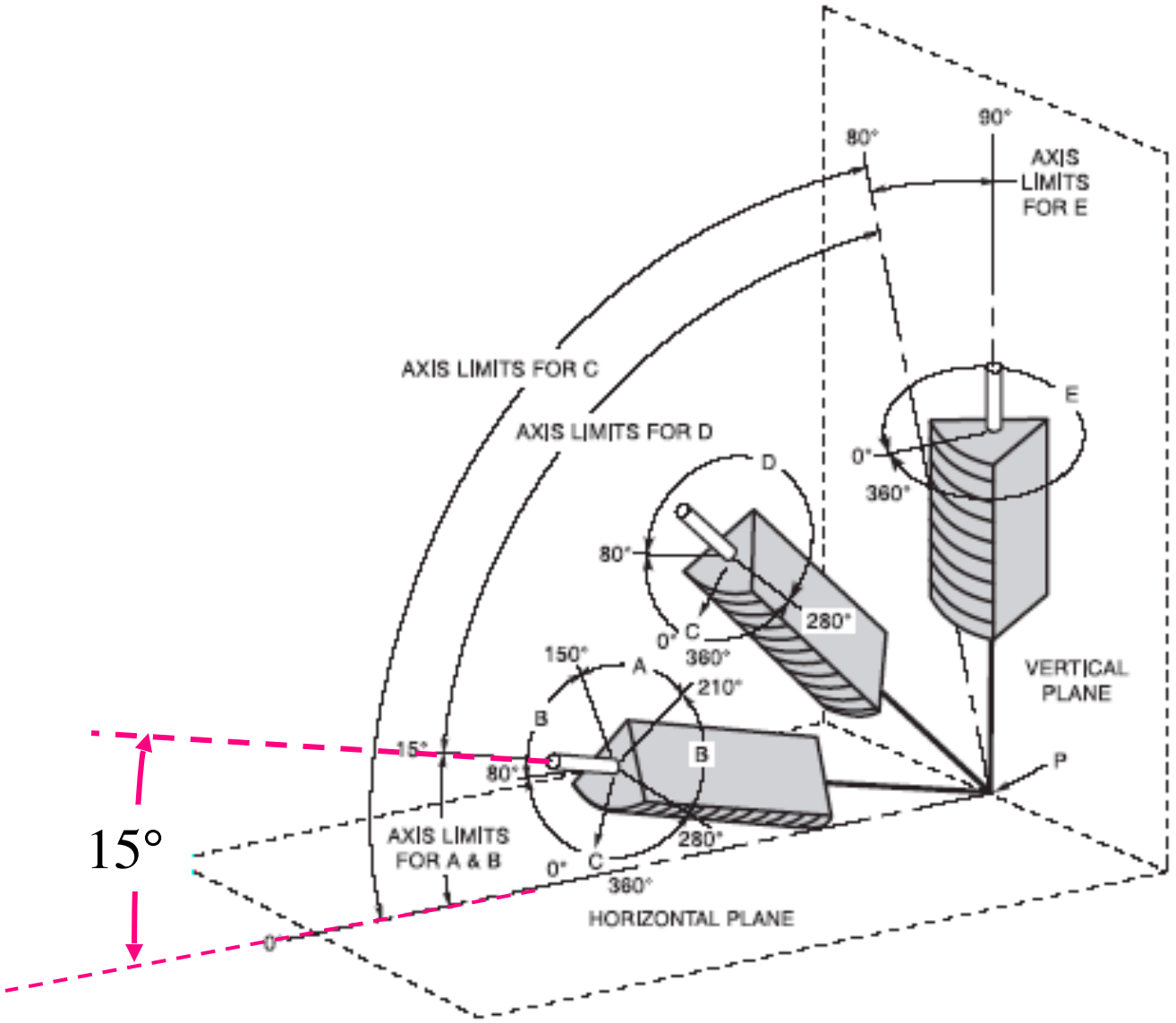
Welding Positions

Tabulation of Positions of Groove Welds

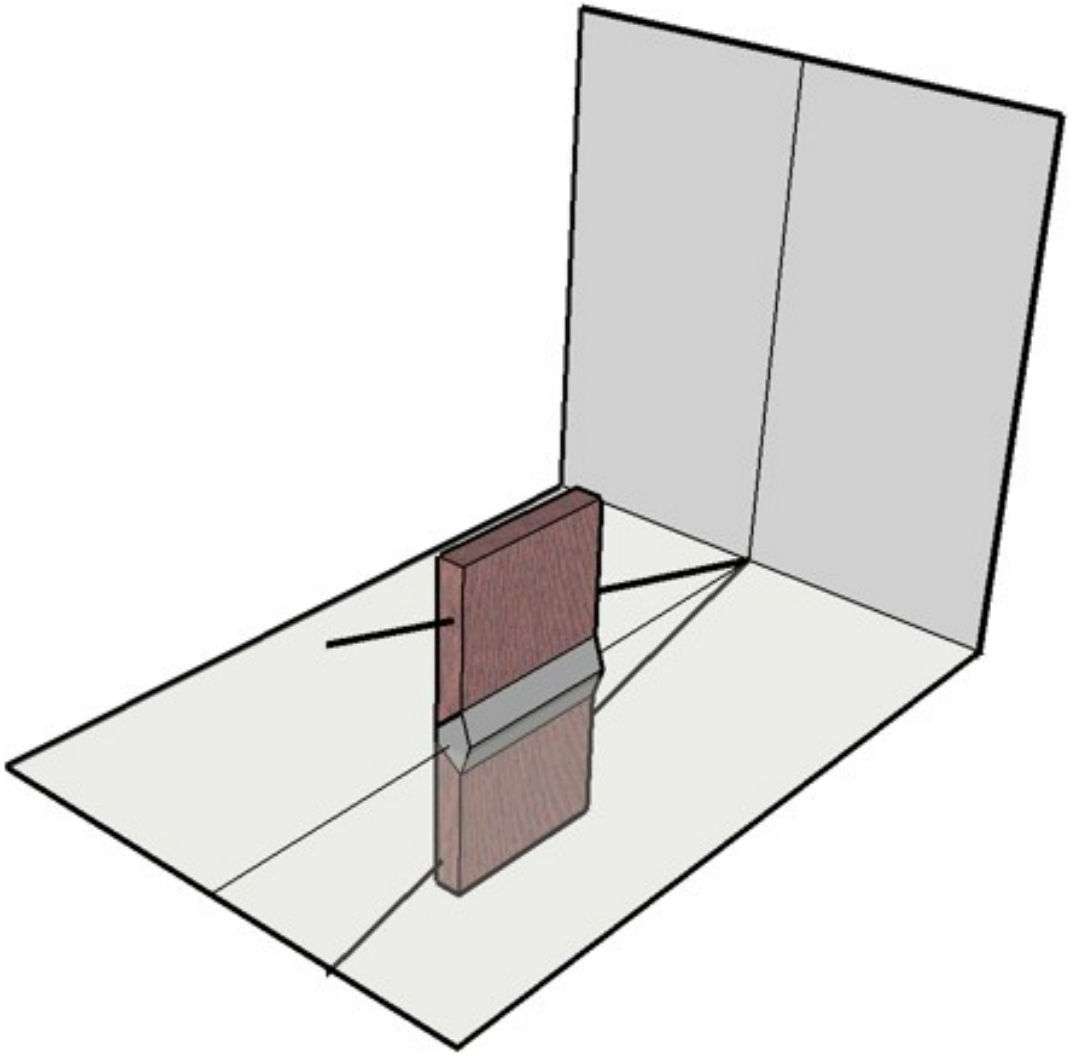
Position	Diagram Reference	Inclination of Axis	Rotation of Face
Flat	A	0 to 15°	150 to 210°
Horizontal	**B**	**0 to 15°**	80 to 150°
			210 to 280°
Overhead	C	0 to 80°	0 to 80°
			210 to 360°
Vertical	D	15 to 80°	80 to 280°
	E	80 to 90°	0 to 360°

How this table and the diagram on the previous page work are shown in the following diagrams

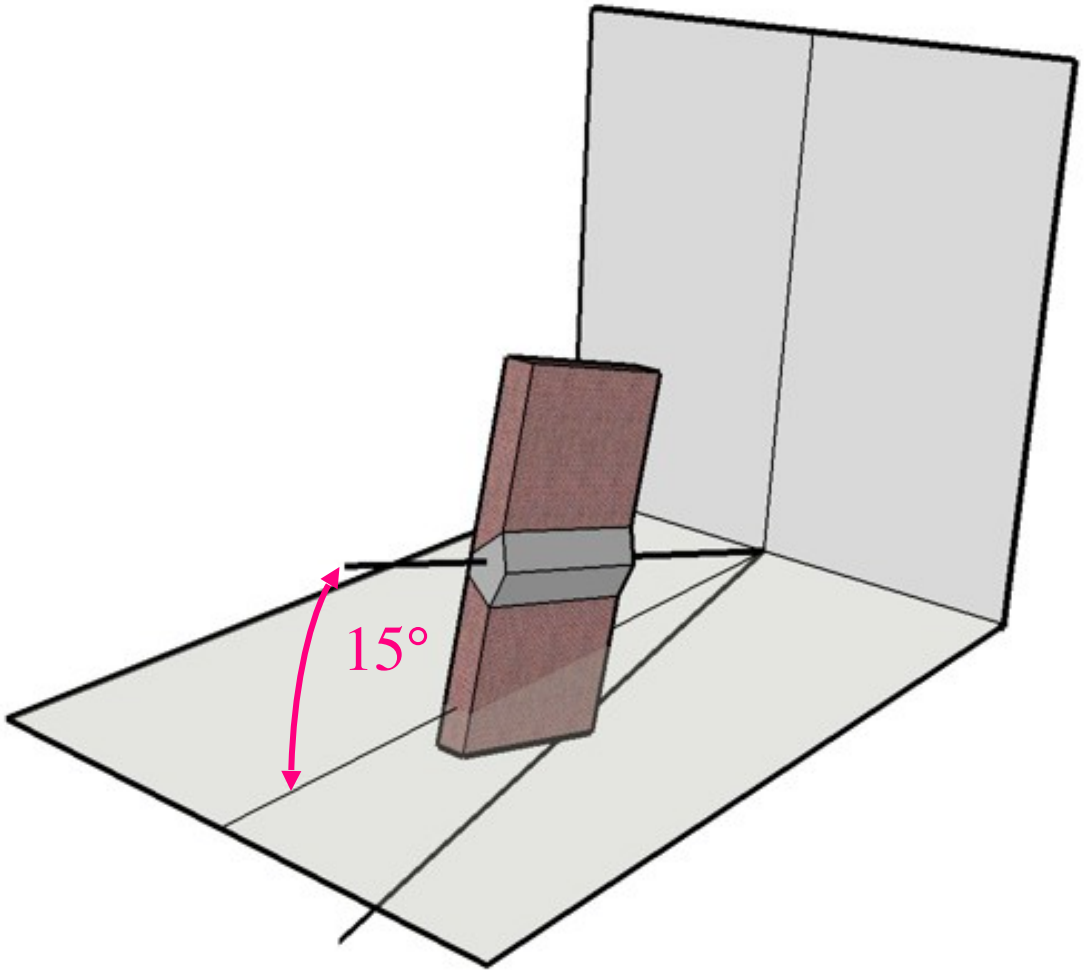
Horizontal Position Axis Inclined



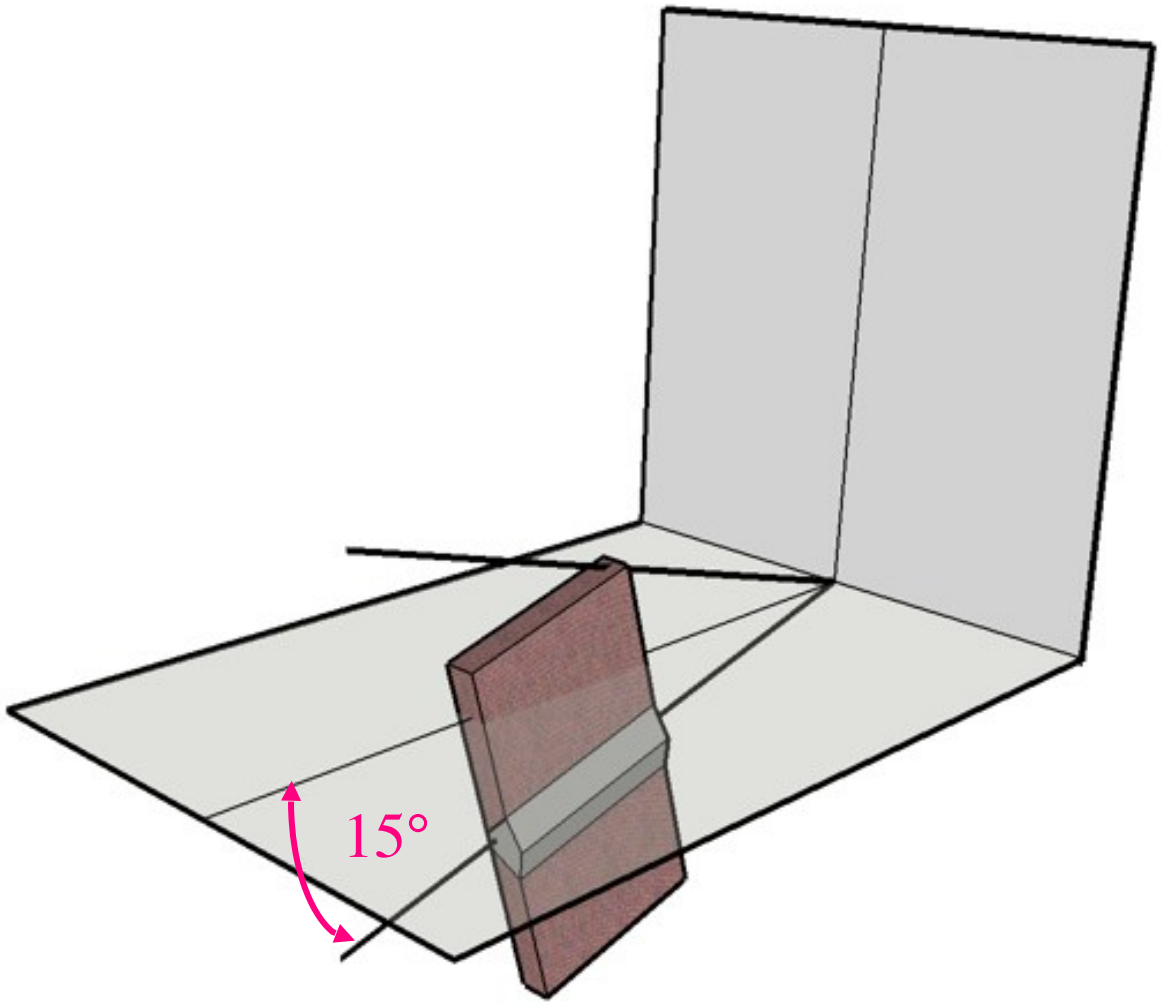
Basic Horizontal Position



Horizontal Position Uphill Inclined Limit



Horizontal Position Downhill Inclined Limit



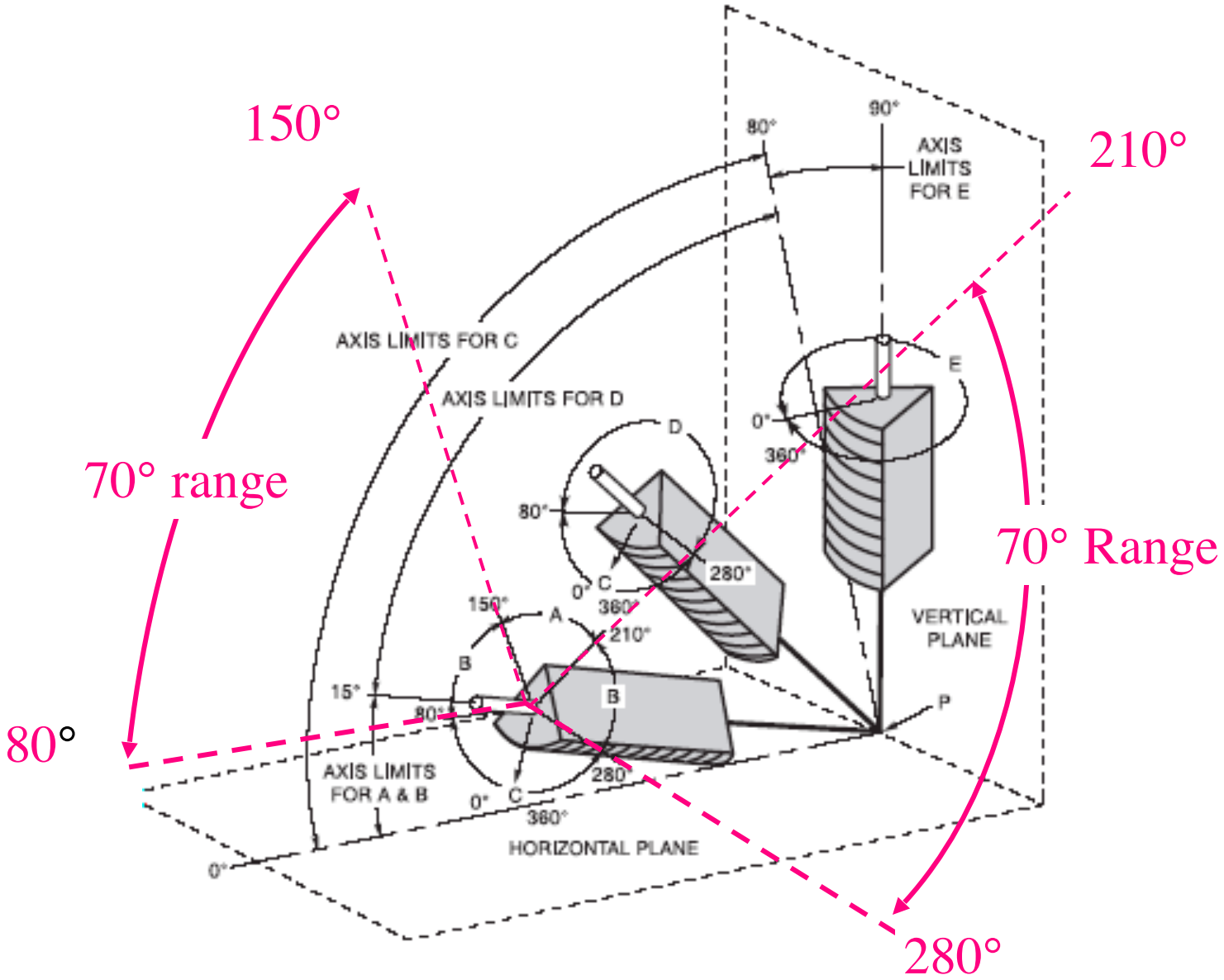
Welding Positions

Tabulation of Positions of Groove Welds

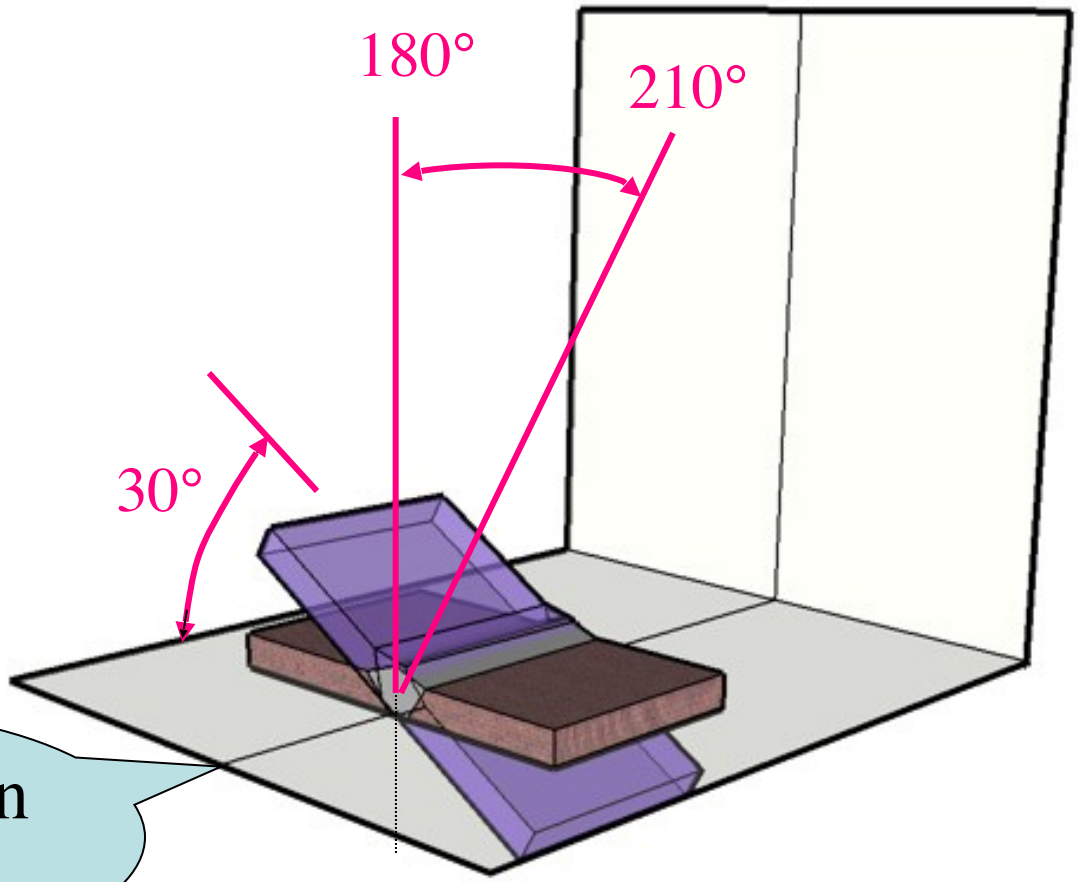
Position	Diagram Reference	Inclination of Axis	Rotation of Face
Flat	A	0 to 15°	150 to 210°
Horizontal	**B**	0 to 15°	**80 to 150°**
			210 to 280°
Overhead	C	0 to 80°	0 to 80°
			210 to 360°
Vertical	D	15 to 80°	80 to 280°
	E	80 to 90°	0 to 360°

How this table and the diagram on the previous page work are shown in the following diagrams

Horizontal Position Rotated

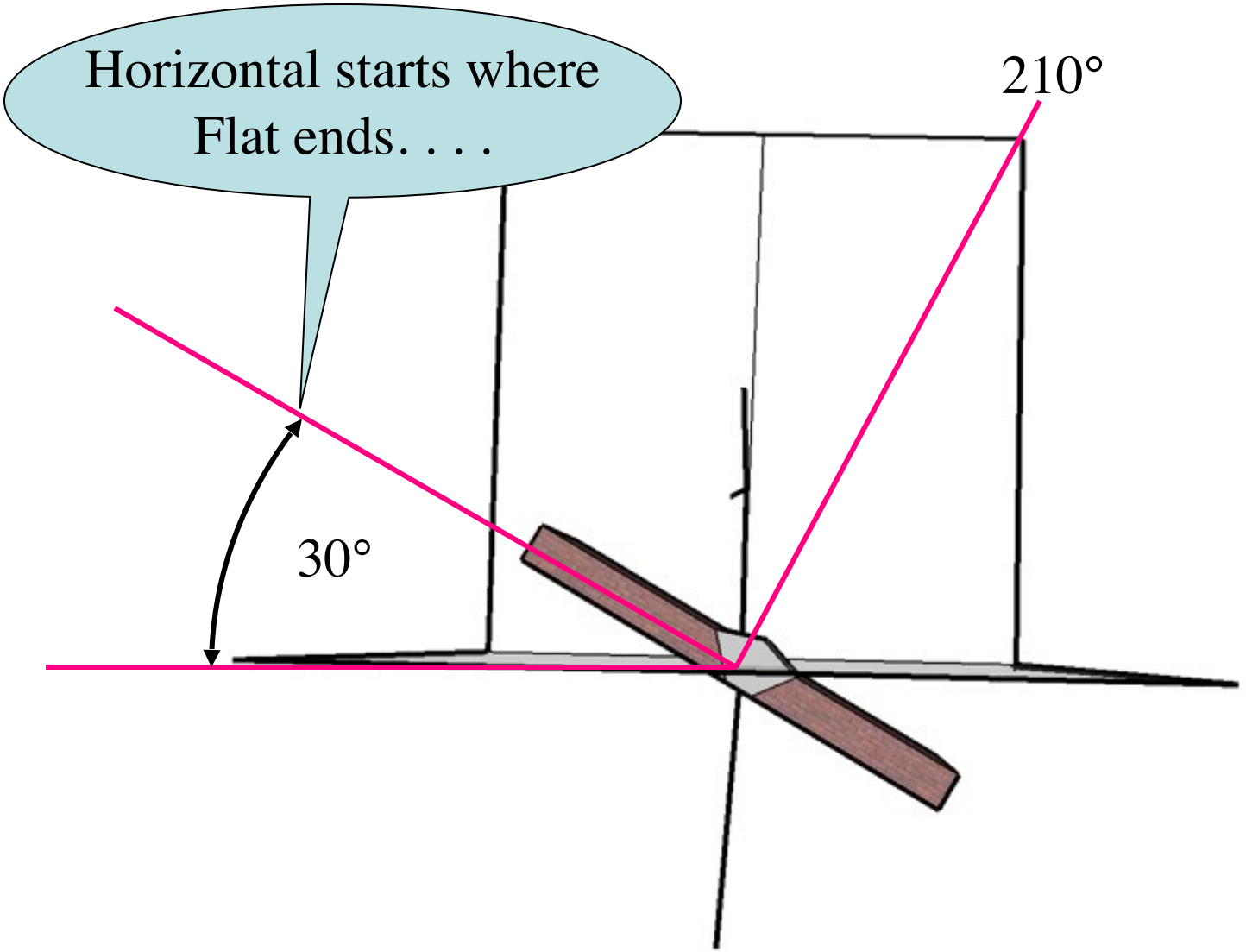


Start at the Flat Rolled Limits

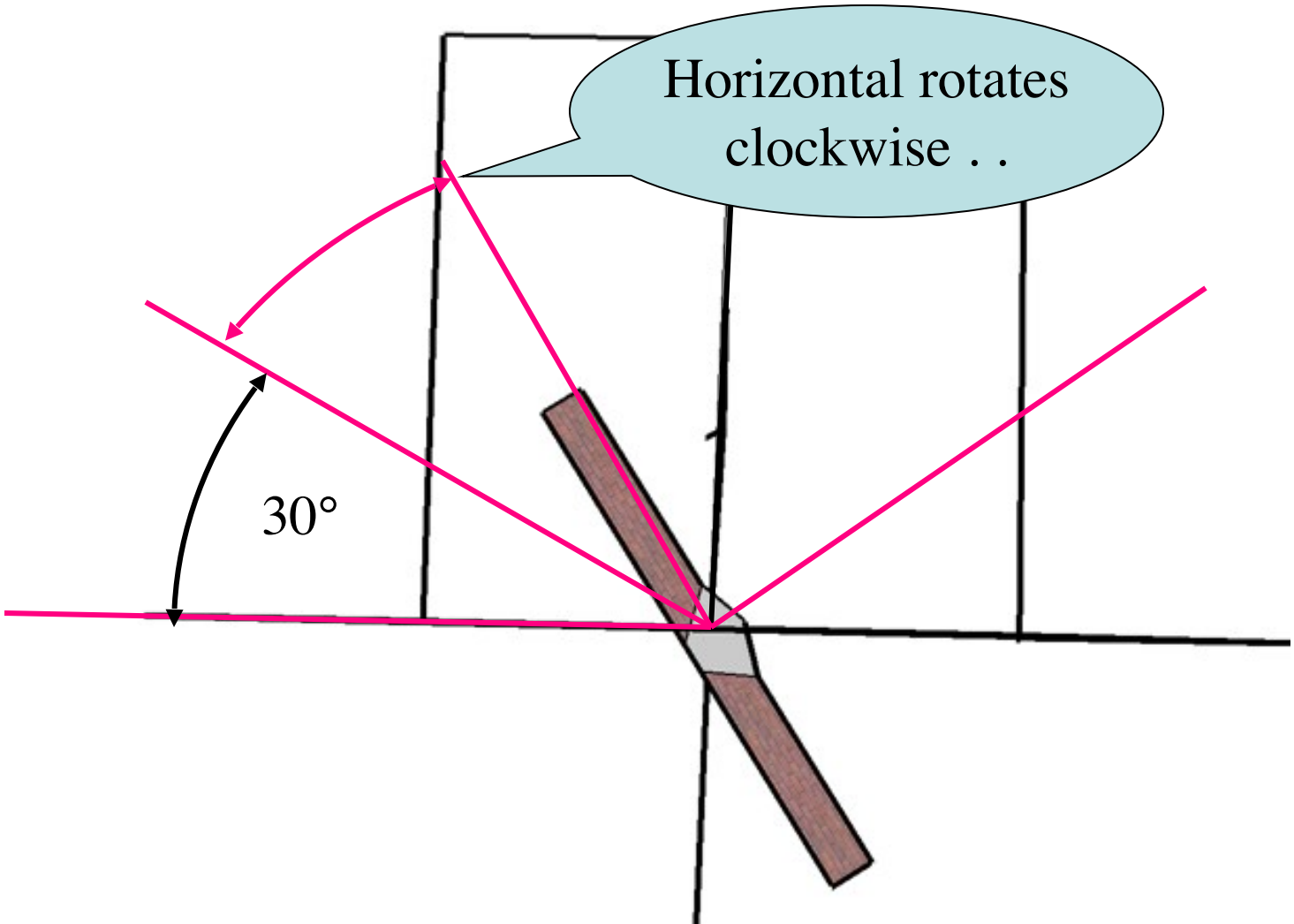


Let's go to an end view. . . .

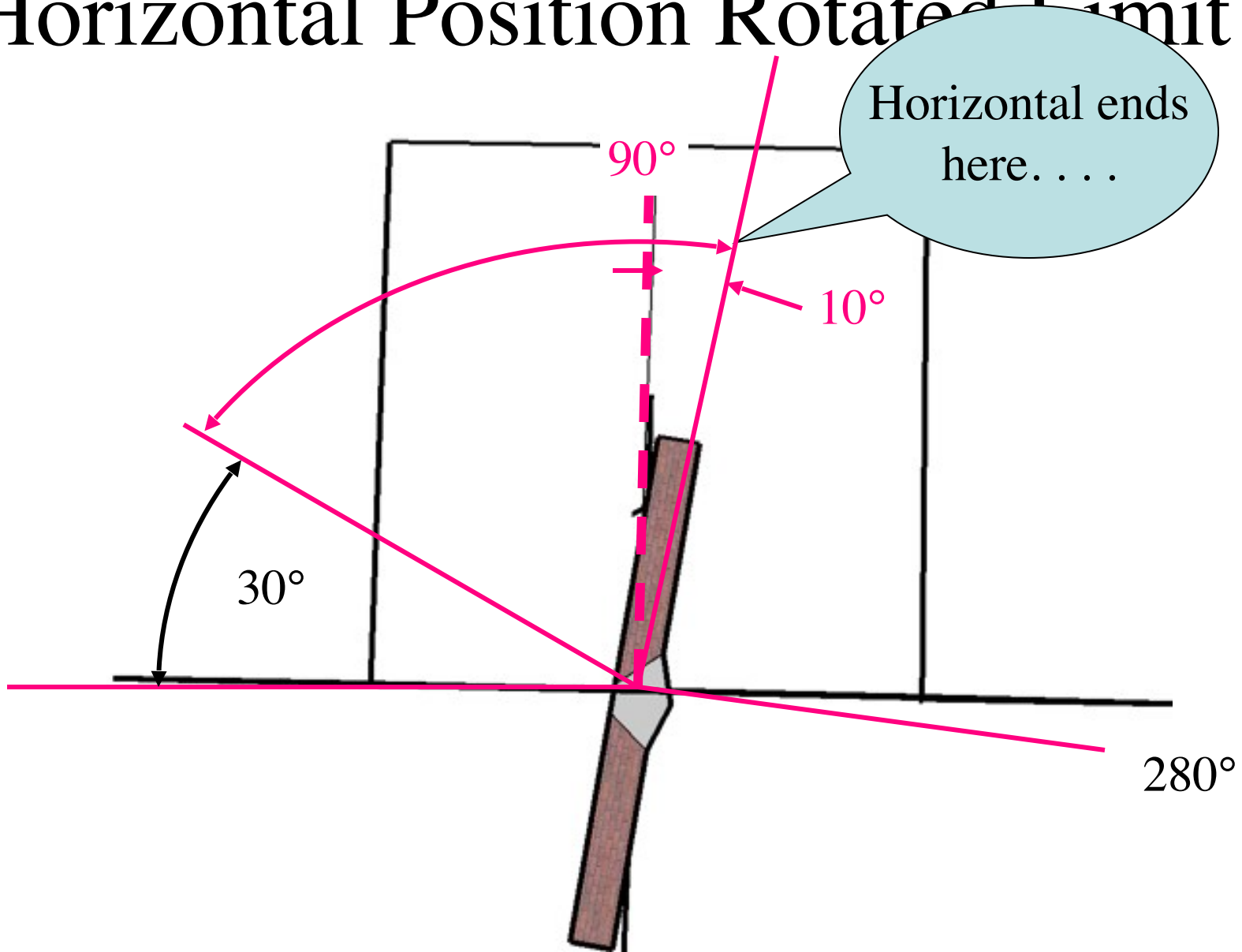
Horizontal End View



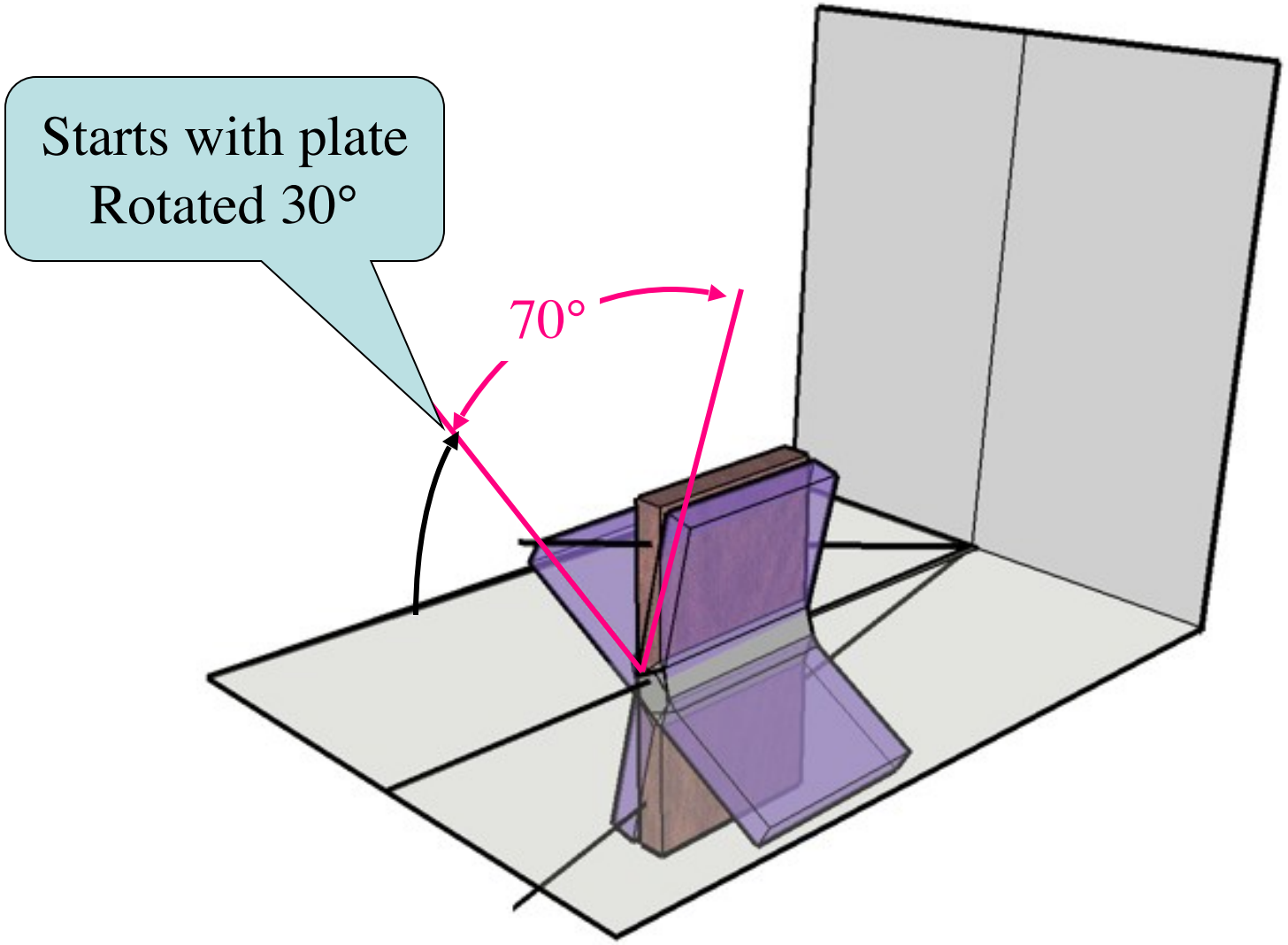
Horizontal Rotates to where the plate is perpendicular to the ground



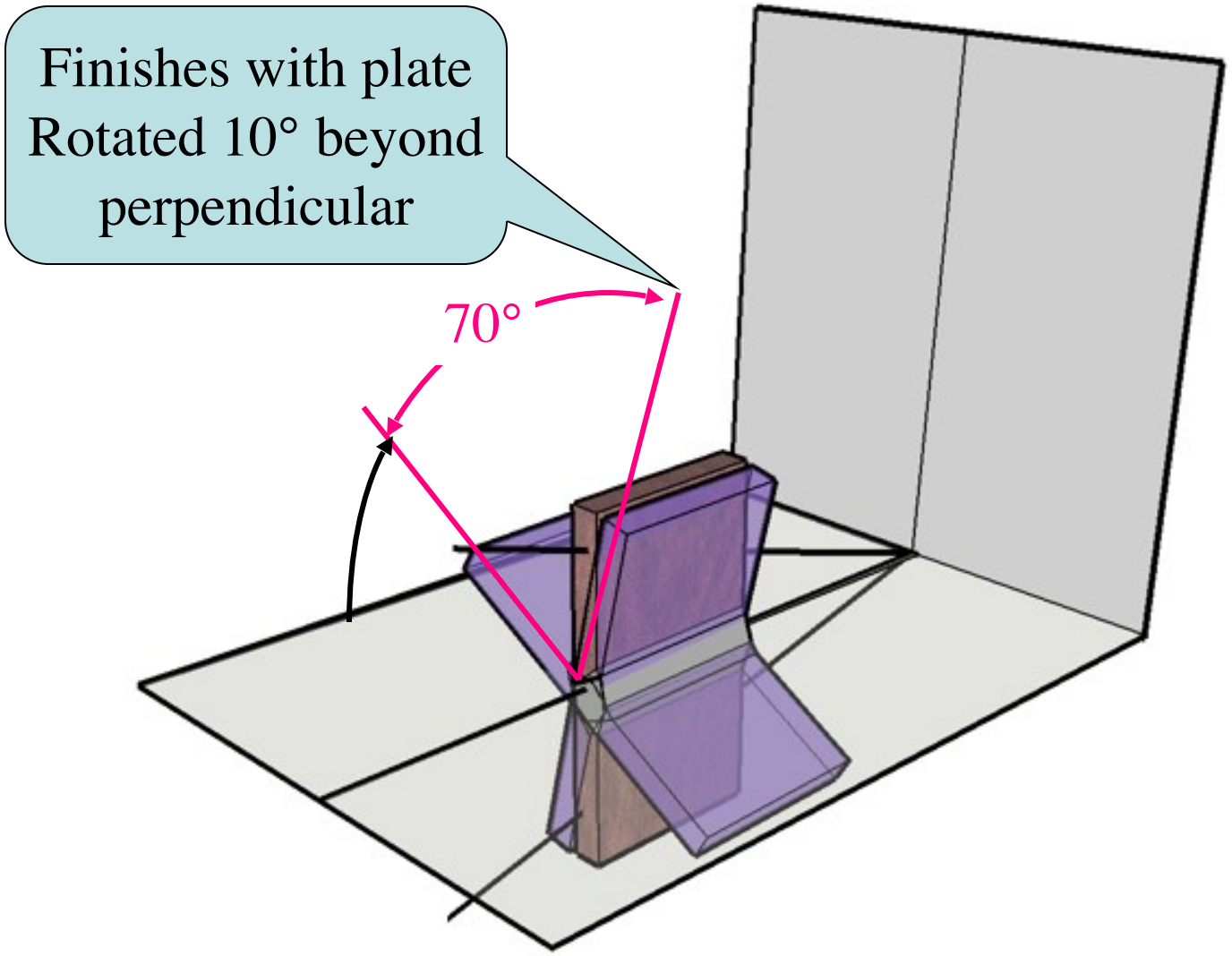
Horizontal Position Rotated Limit



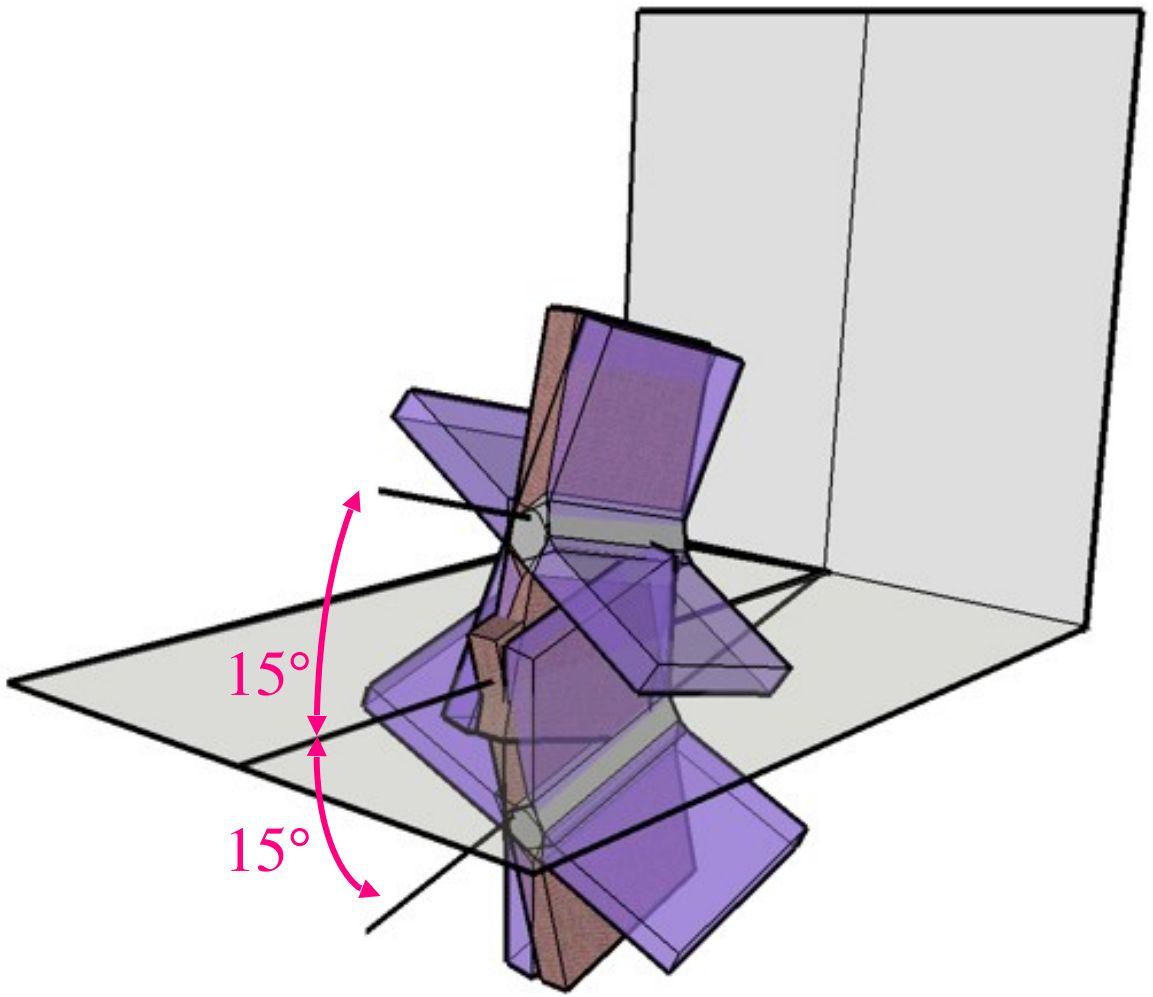
Non-inclined Horizontal Position Limits



Non-inclined Horizontal Position Limits

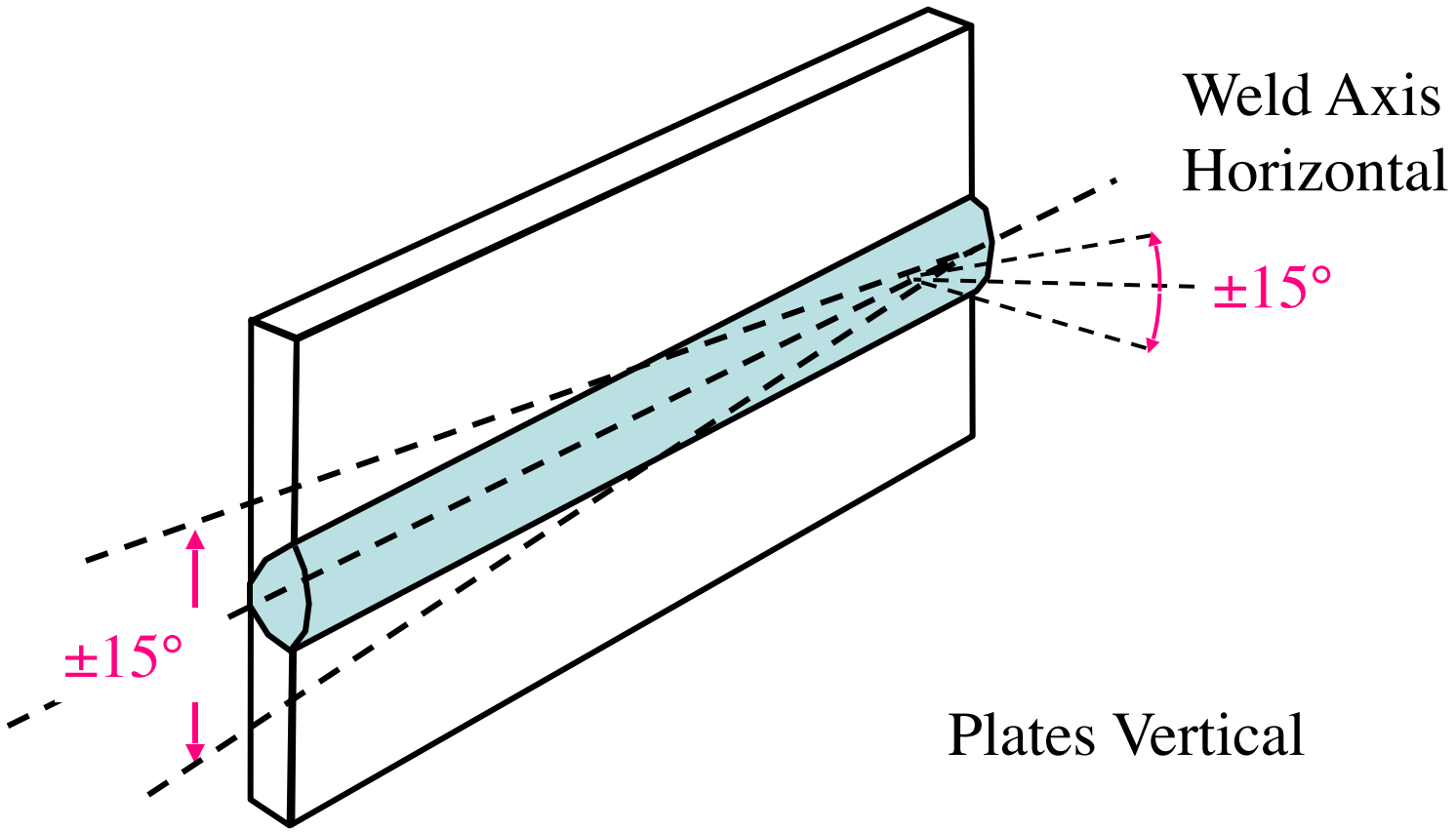


Composite Horizontal Position Limits



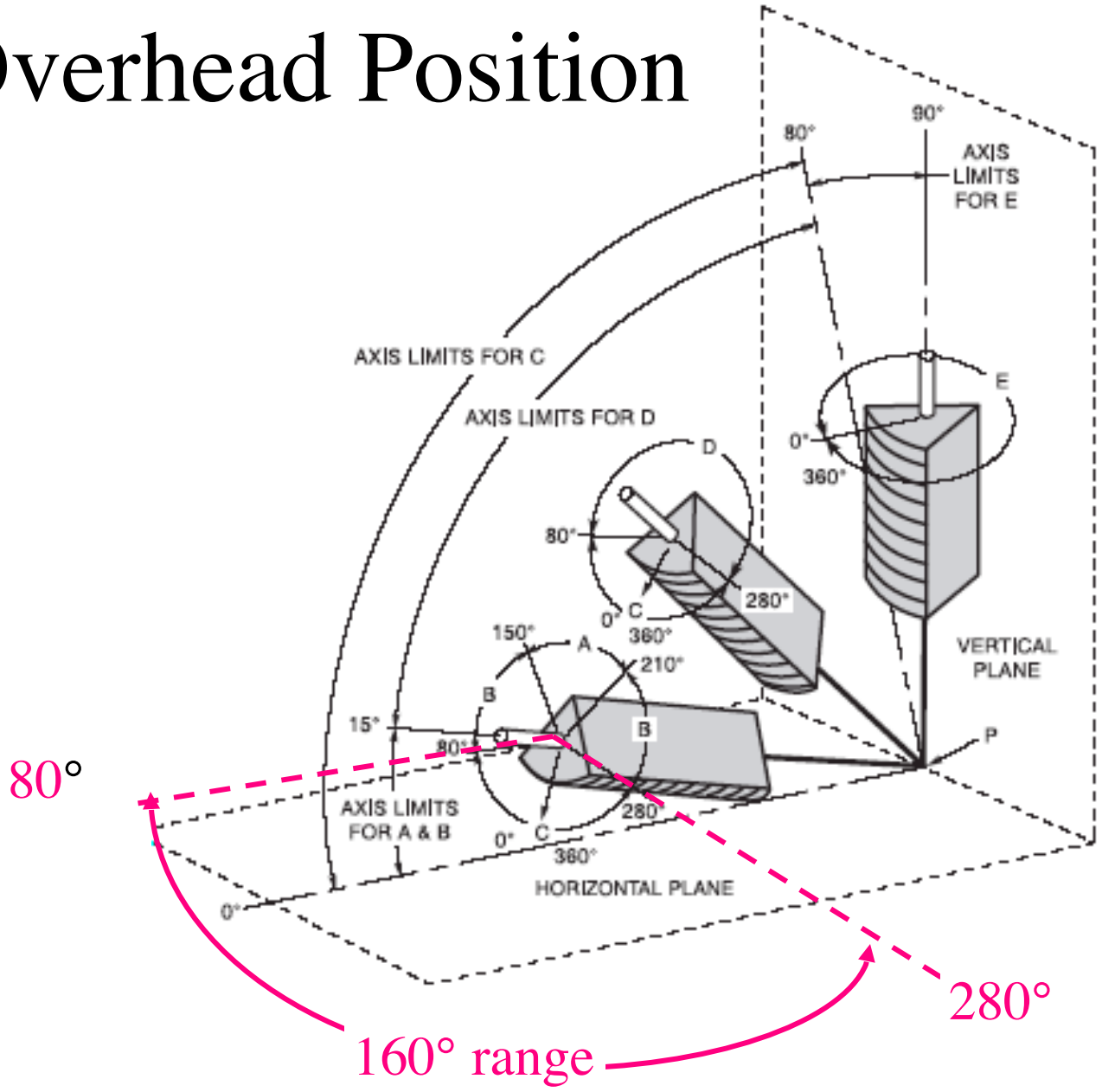
Compare Horizontal to 2G

Test Position 2G/PC

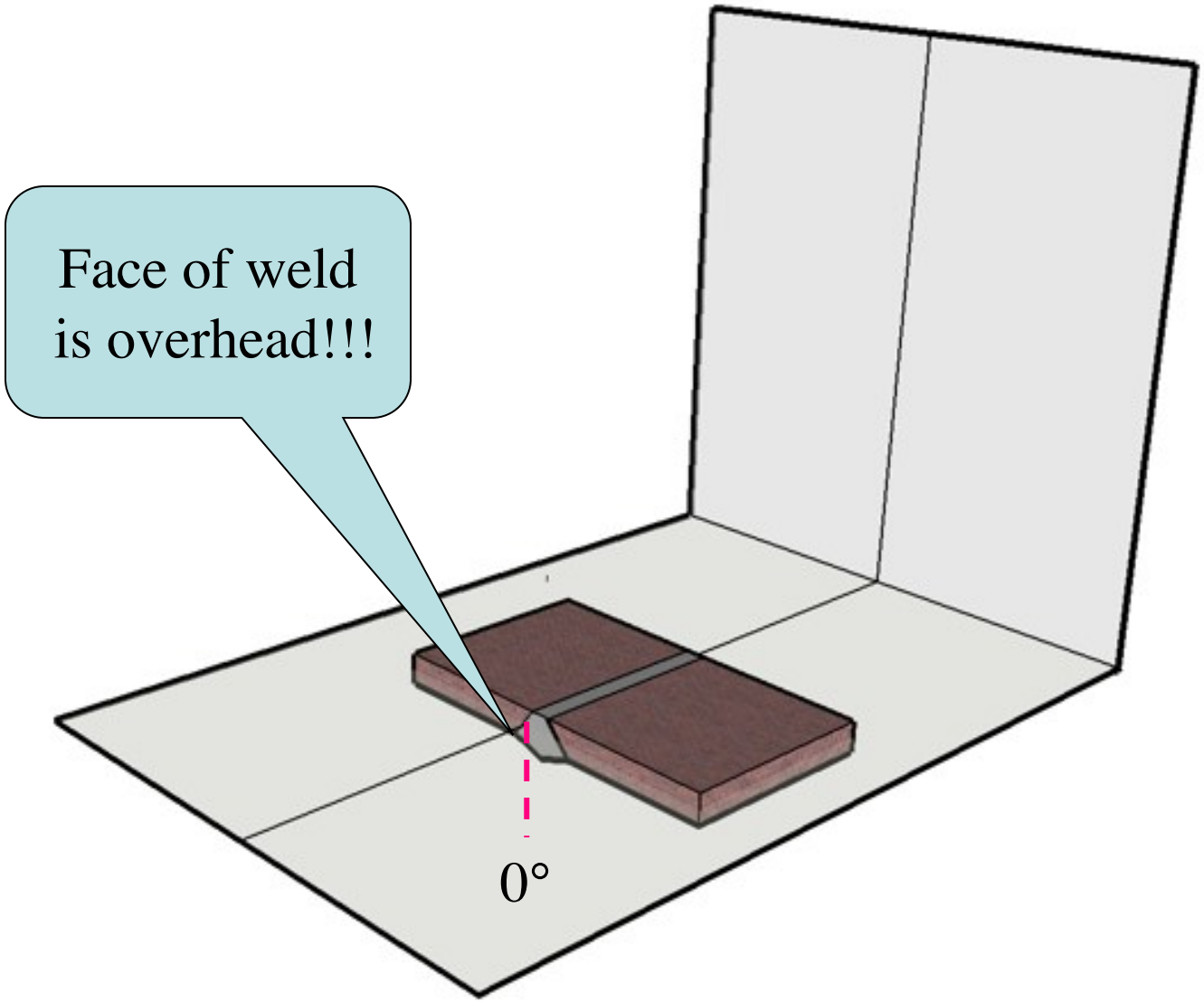


Horizontal ≠ 2G!!!!

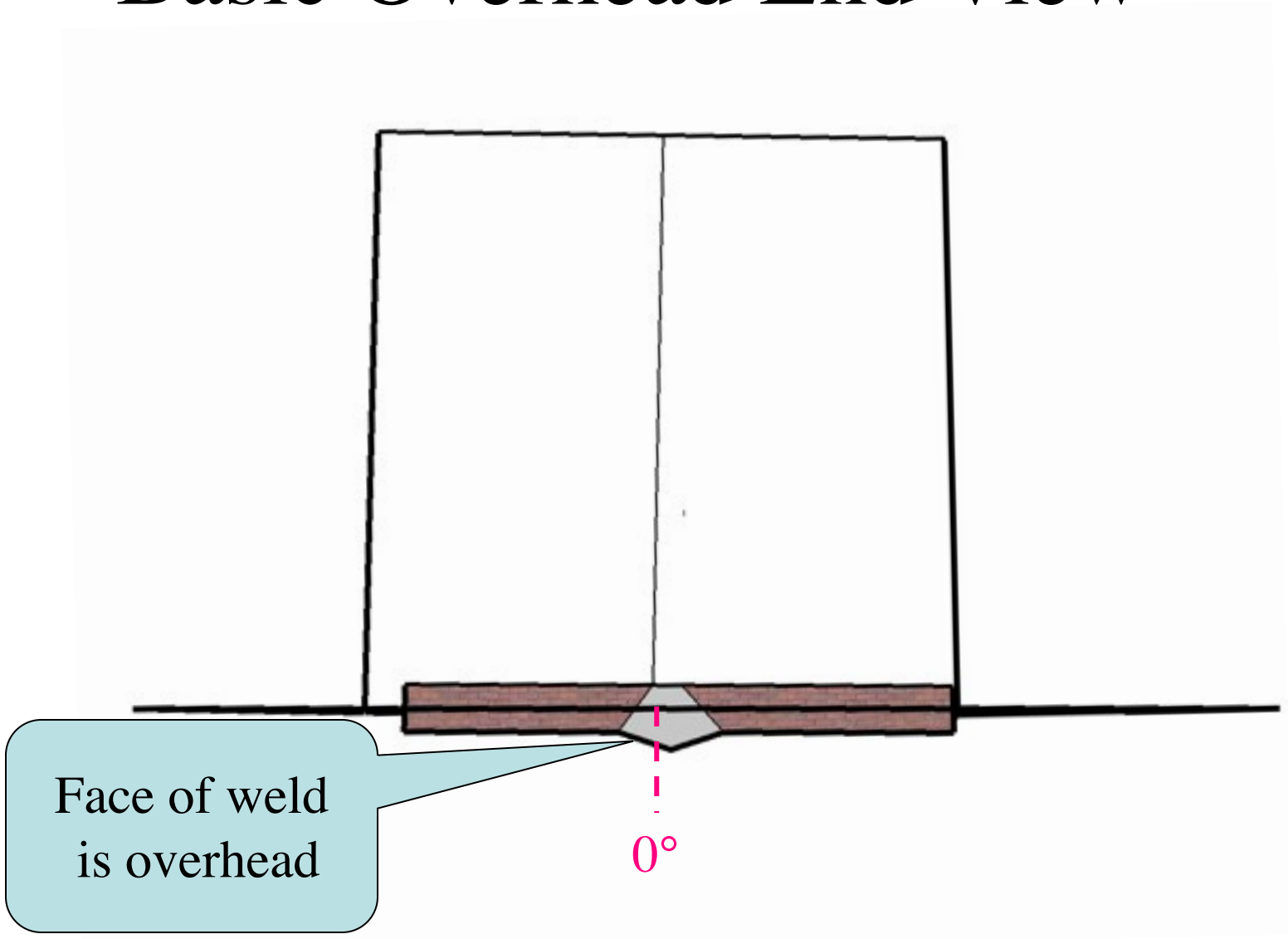
Overhead Position



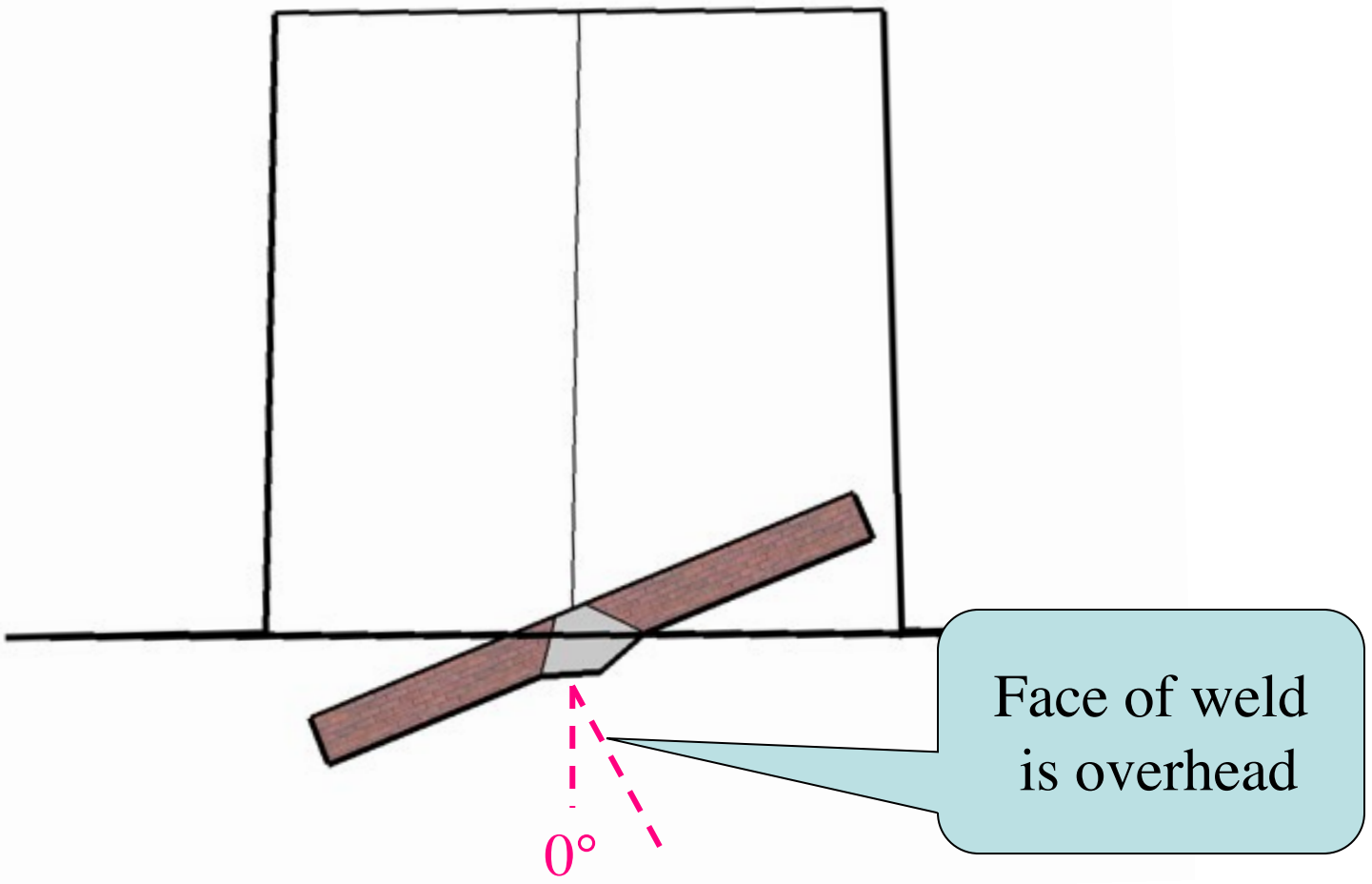
Basic Overhead



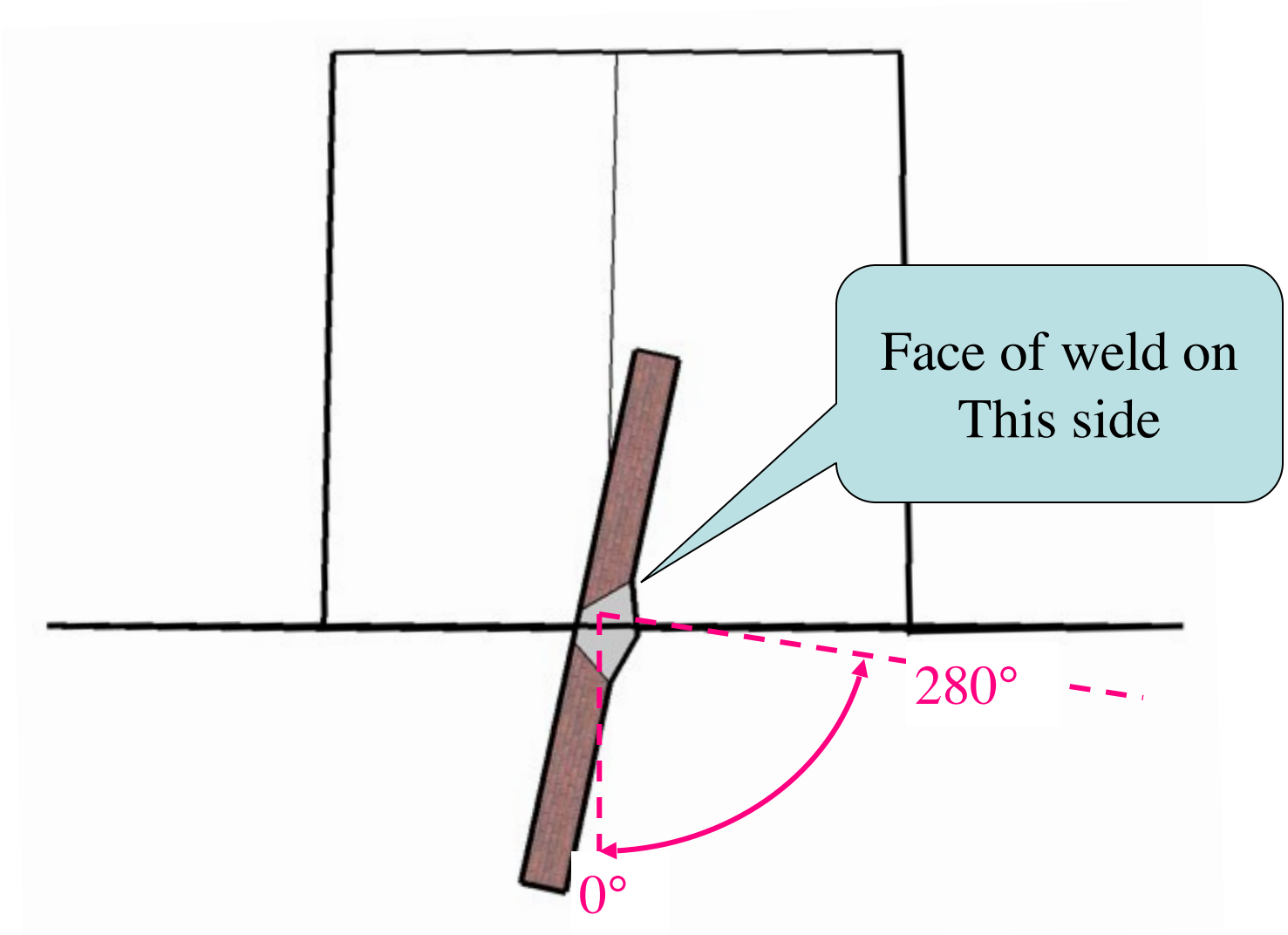
Basic Overhead End View



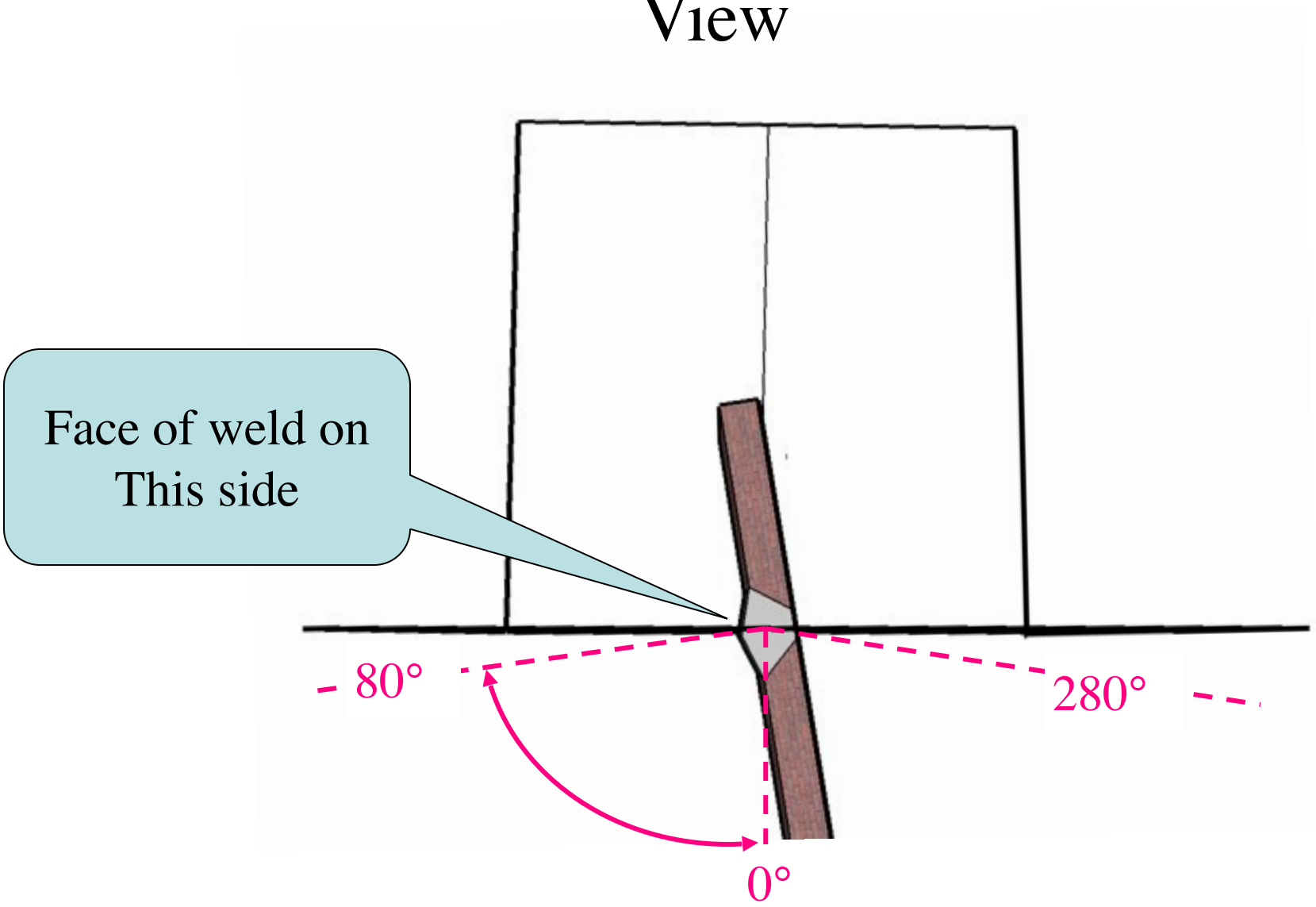
Overhead Partial Rotation
End View



Overhead Maximum Rotation
End View

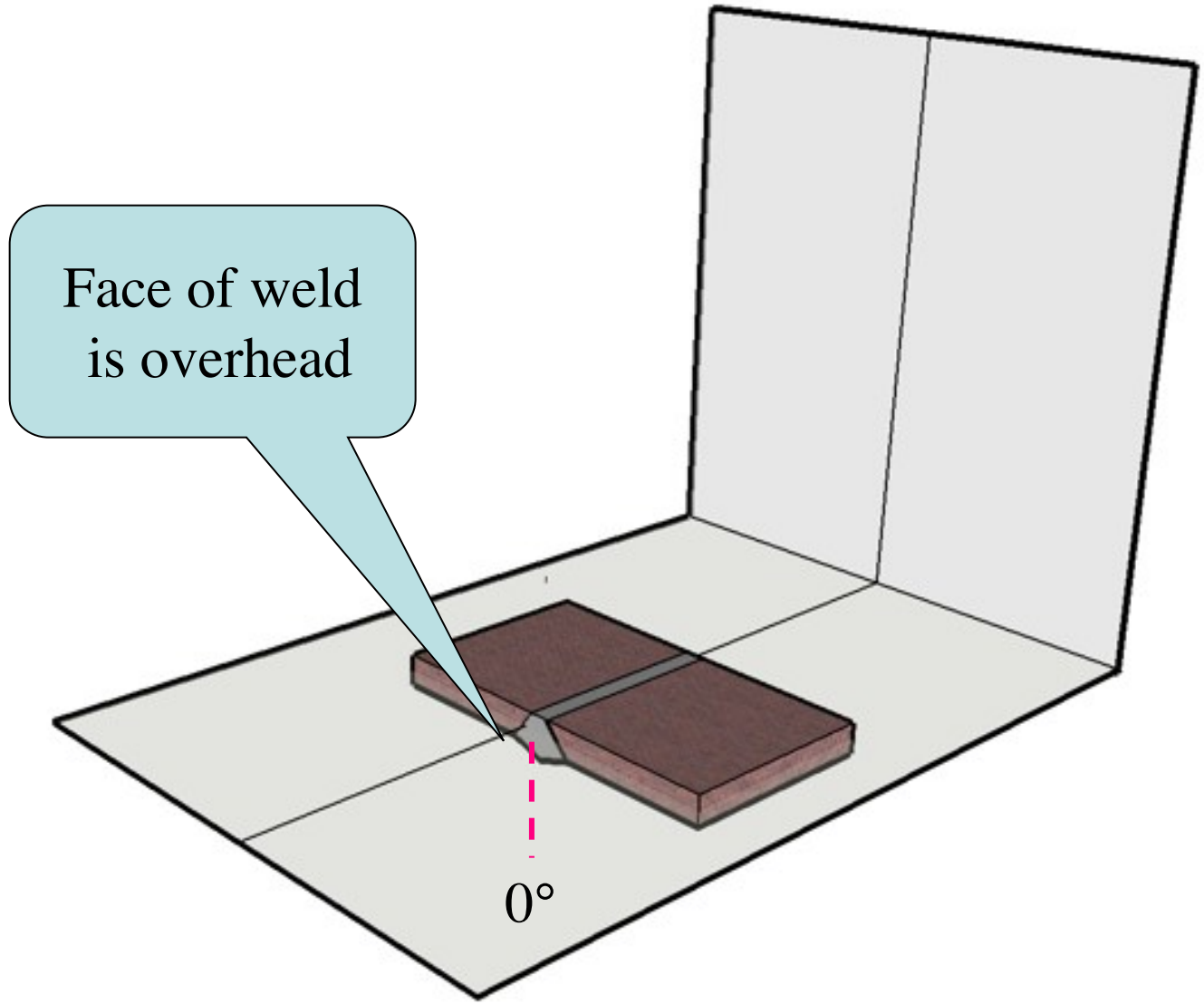


Overhead Maximum Opposite Rotation End View

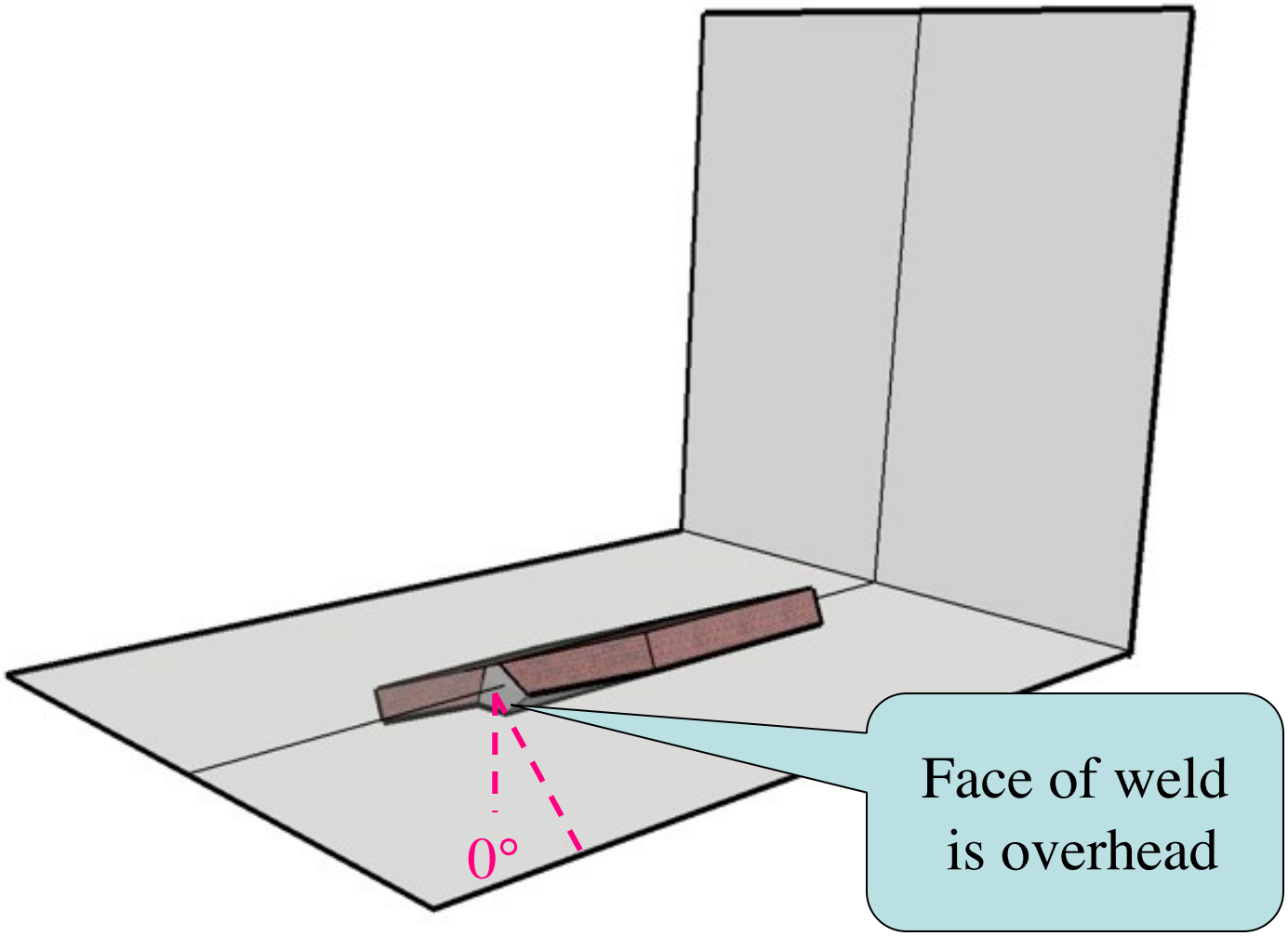


Same Rotation in Isometric View

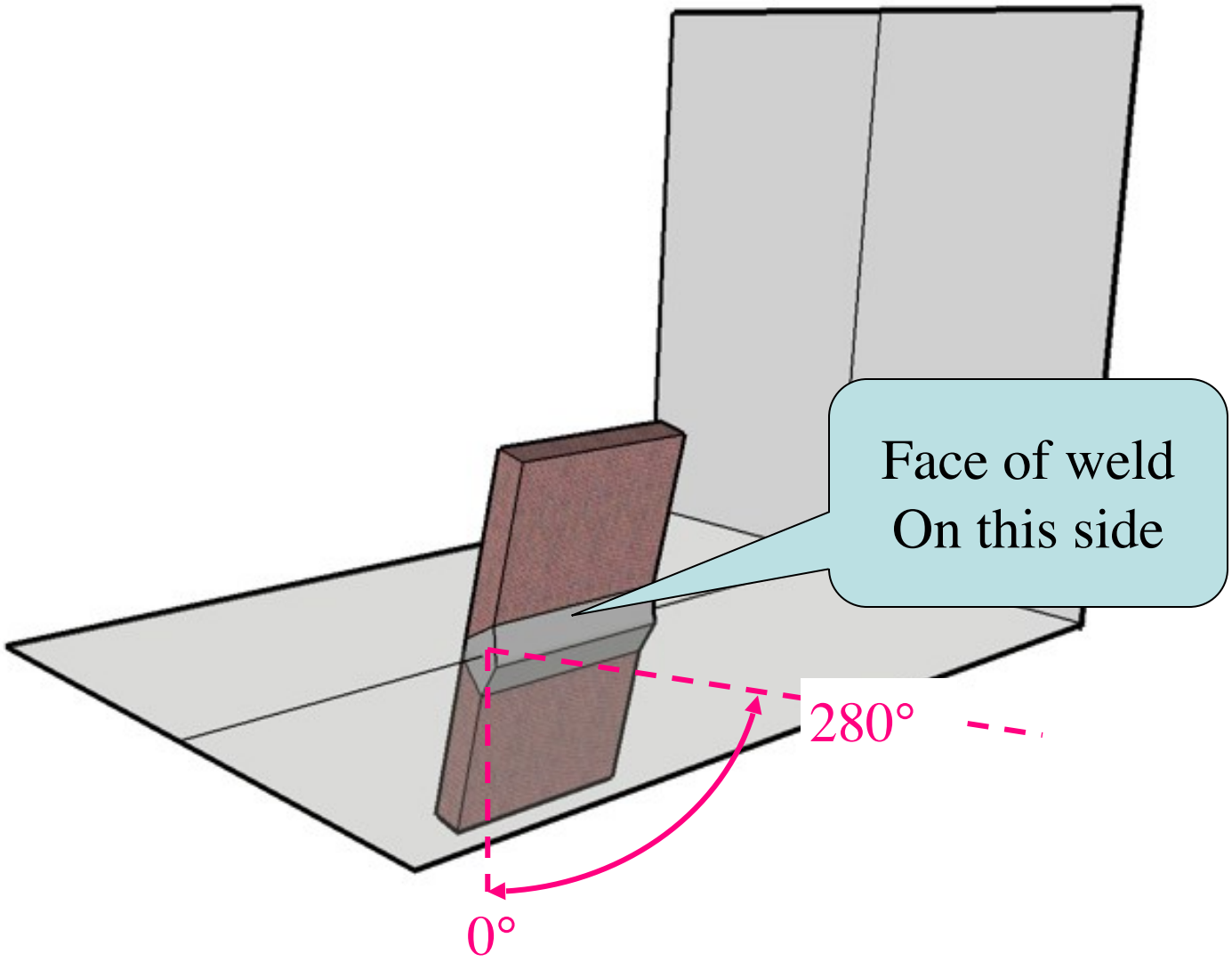
Basic Overhead



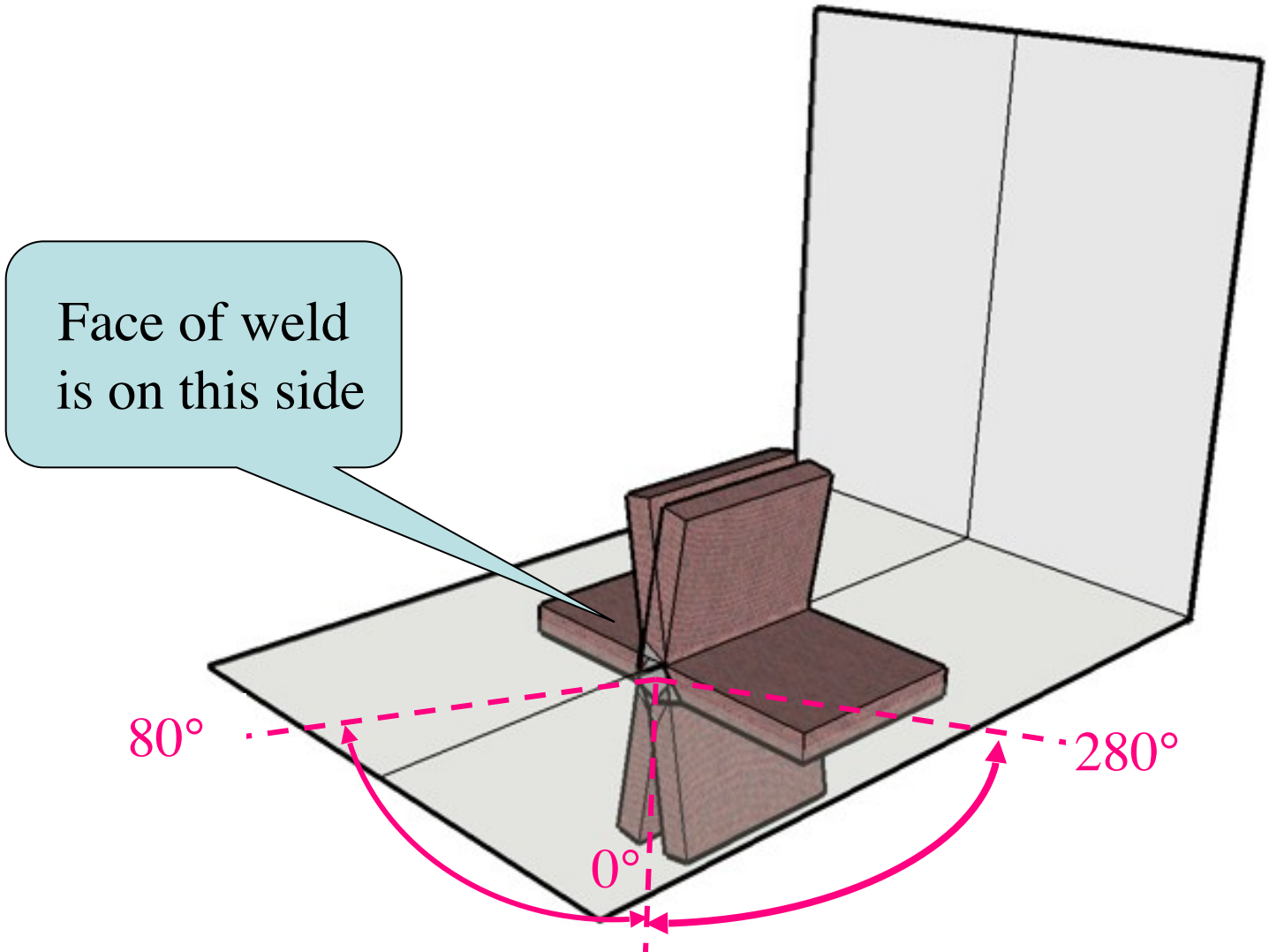
Overhead Partial Rotation
Isometric View



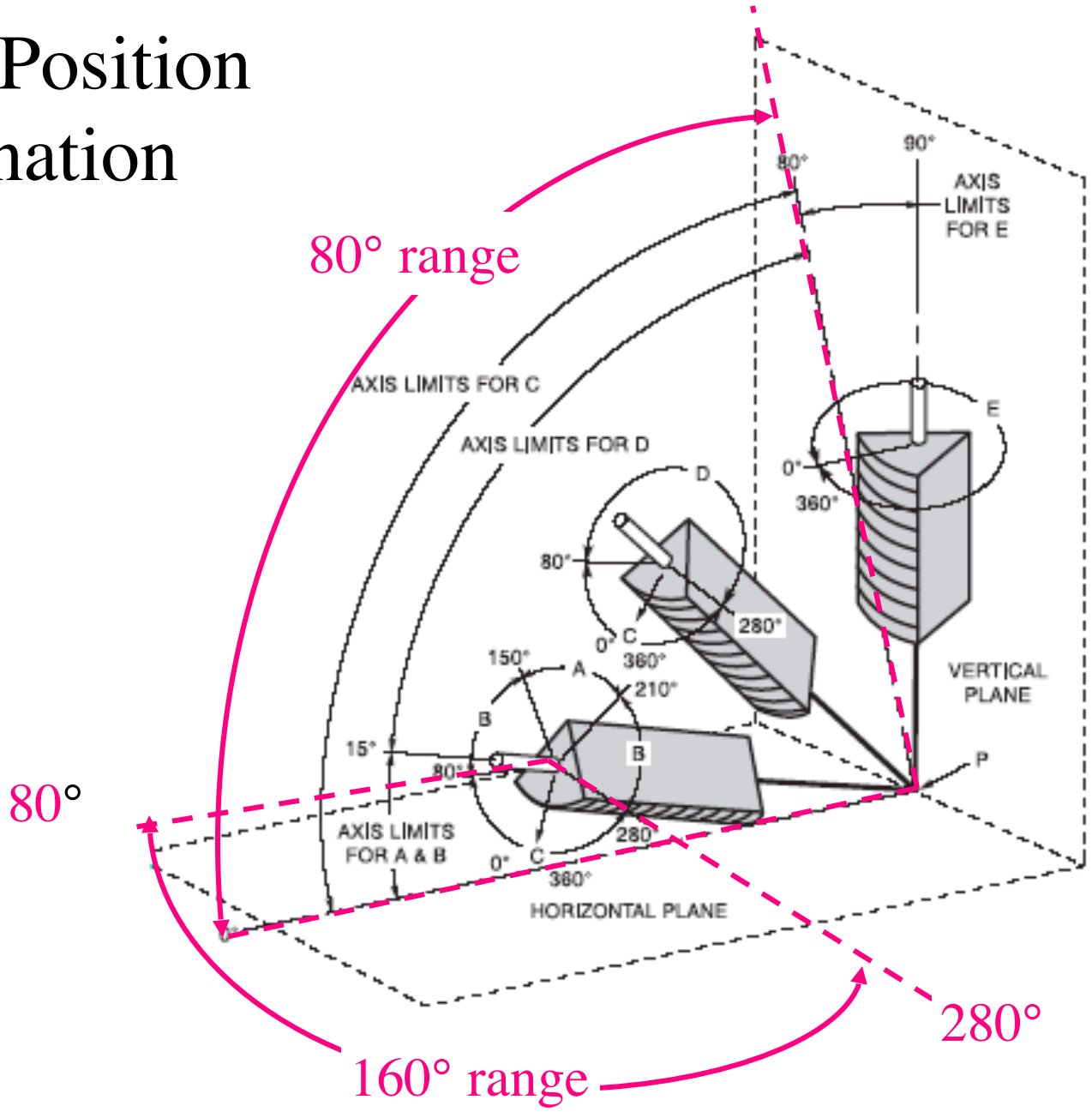
Overhead Maximum Rotation
Isometric View



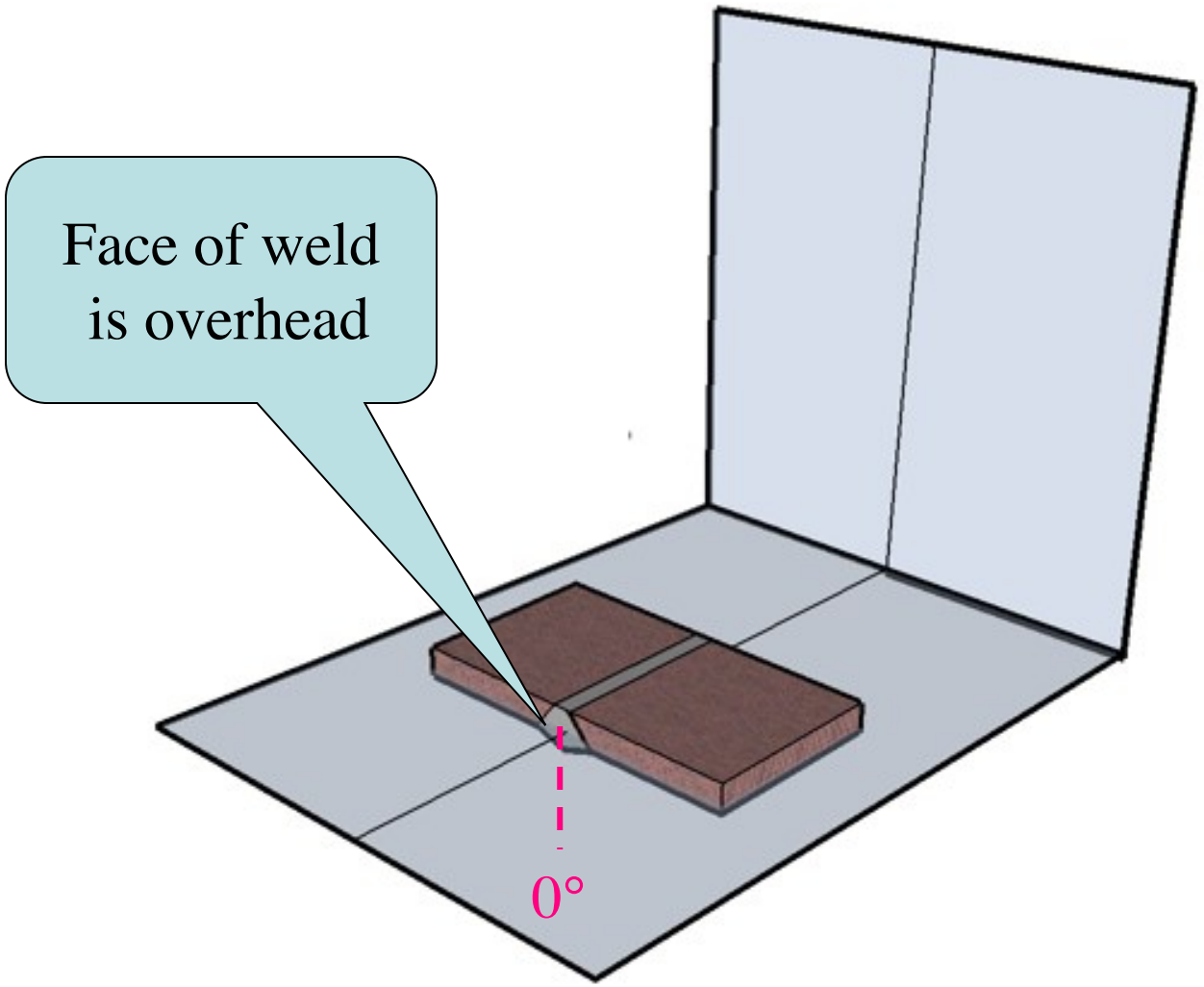
Overhead Maximum Opposite Rotation
Isometric View



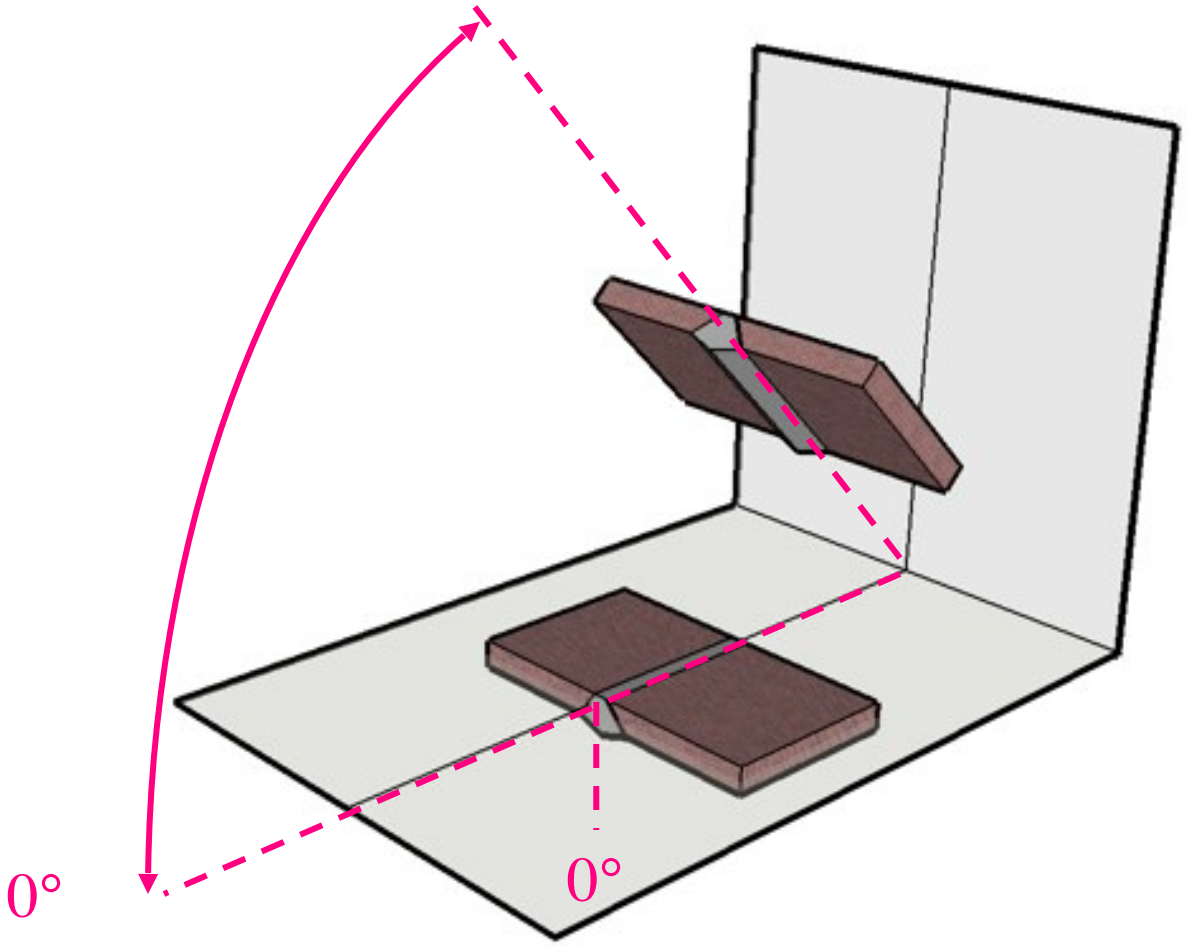
Overhead Position
Axis Inclination



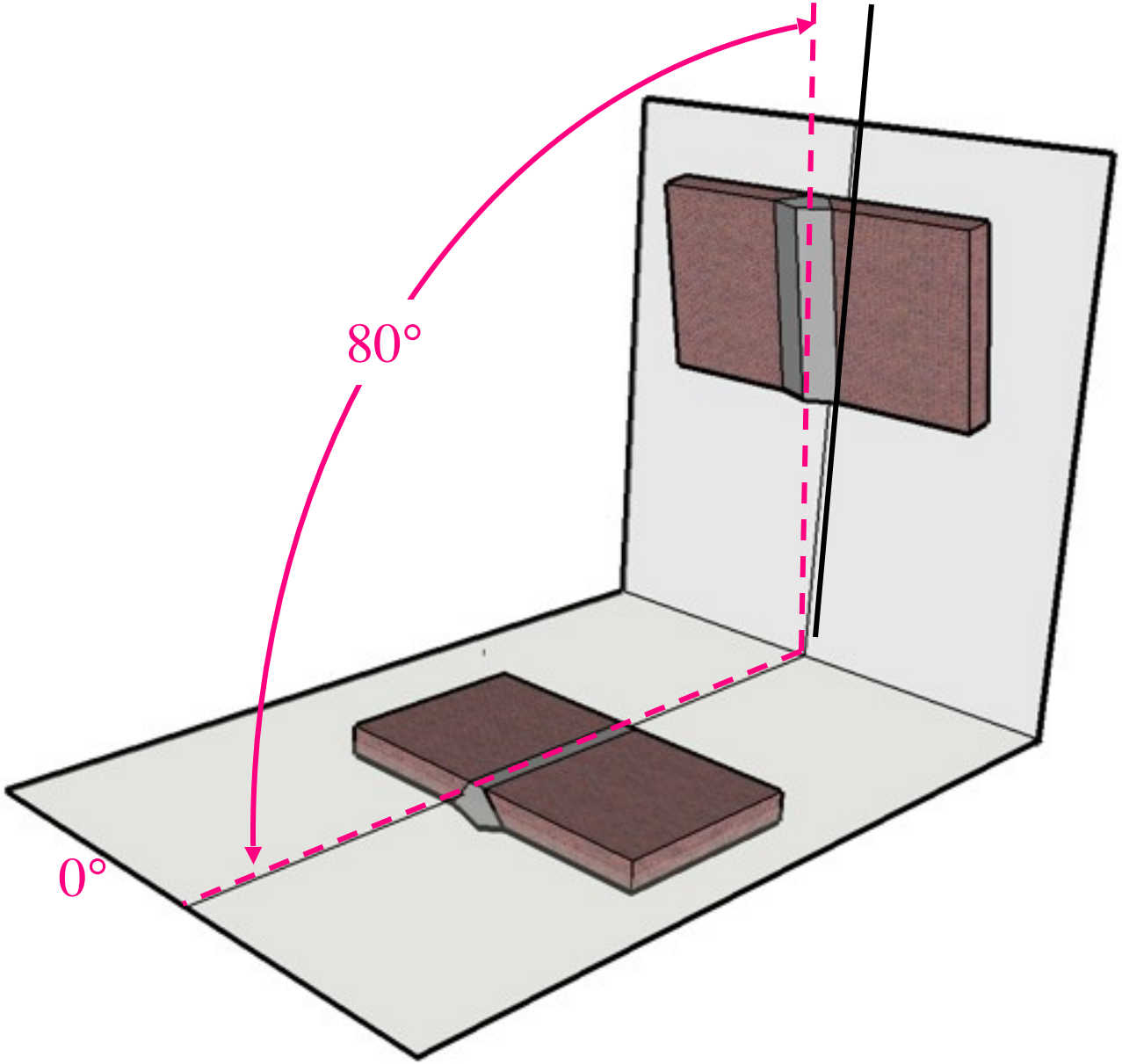
Basic Overhead for Inclined Axis



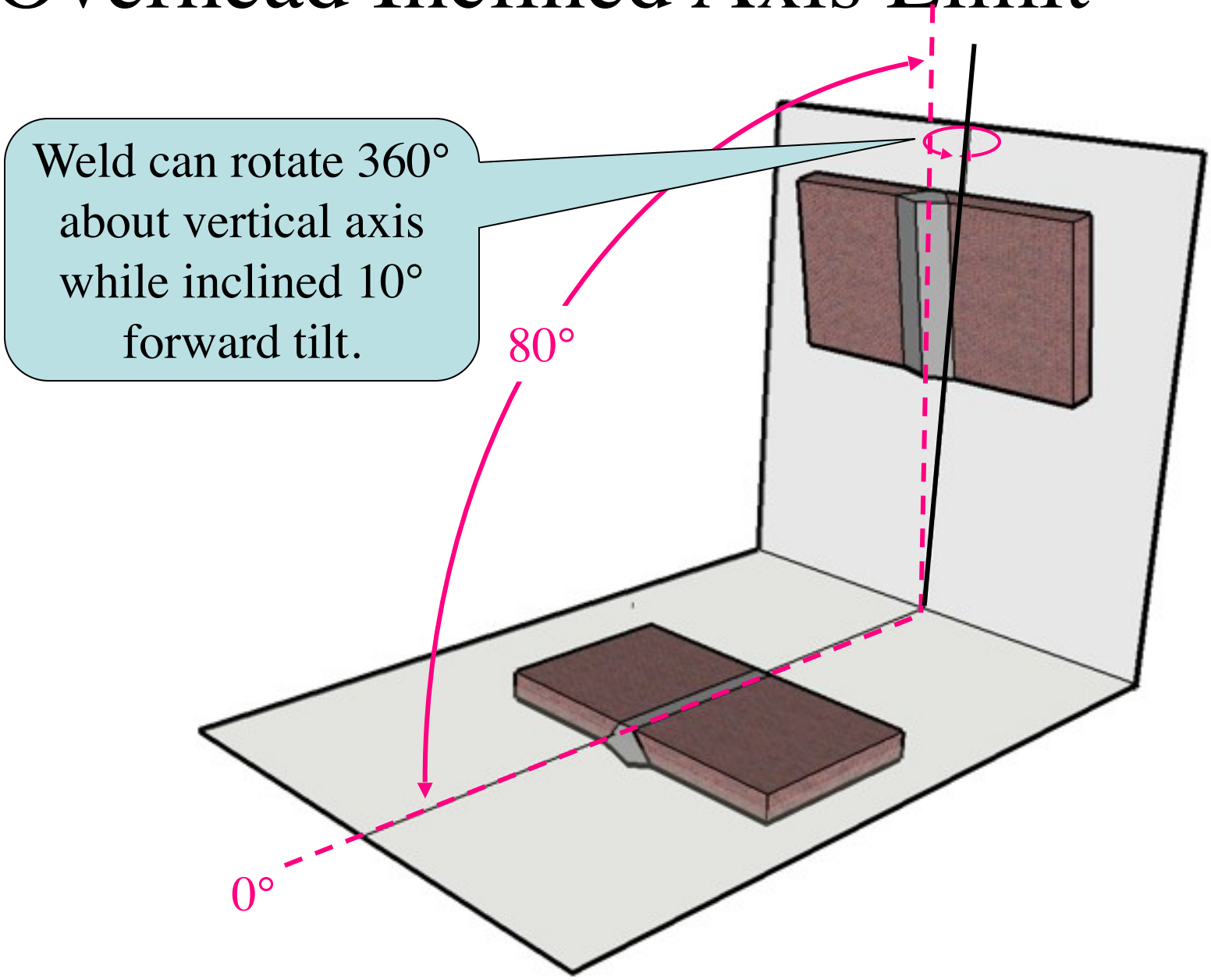
Overhead Inclined Axis Rotation



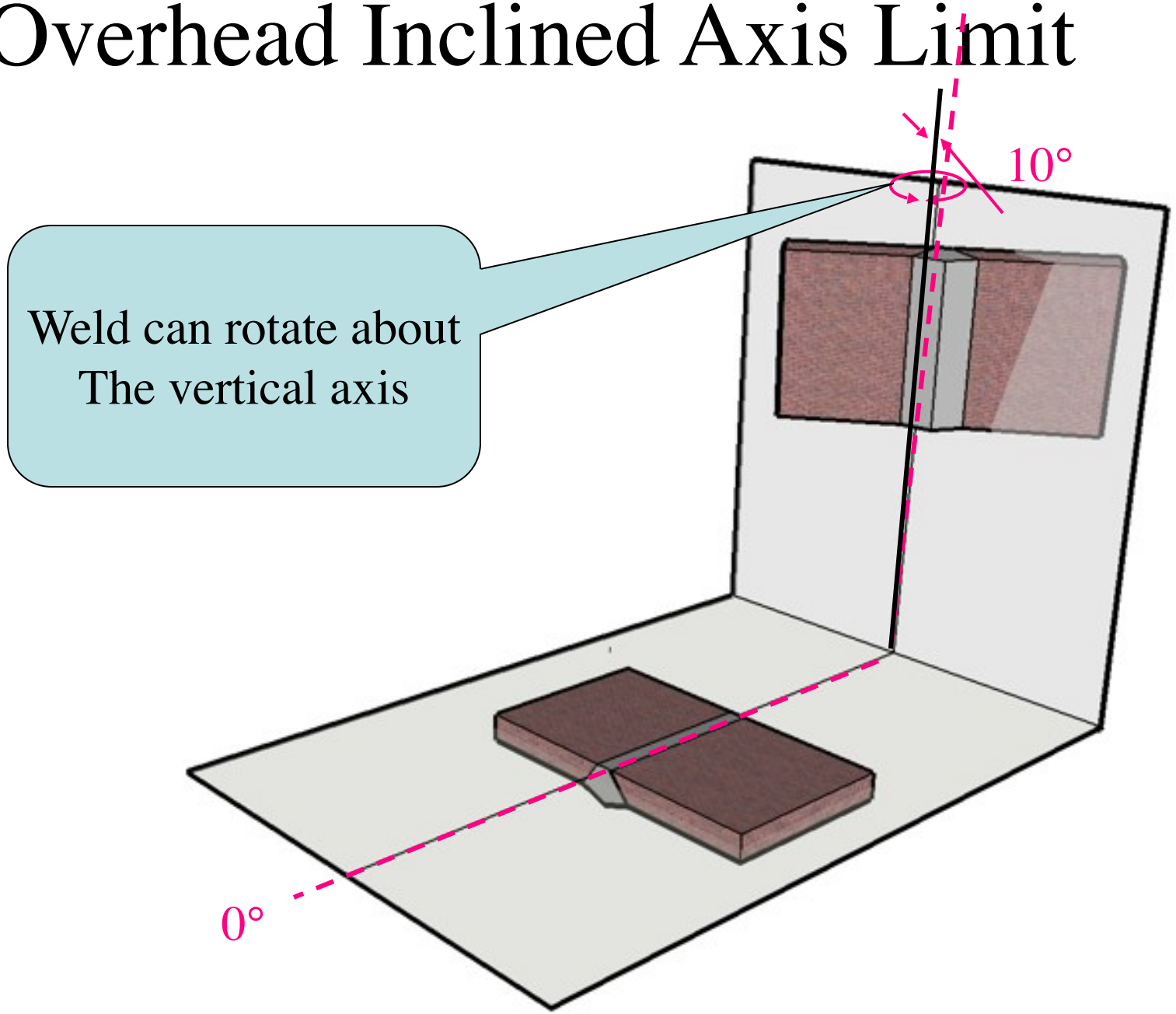
Overhead Inclined Axis Limit



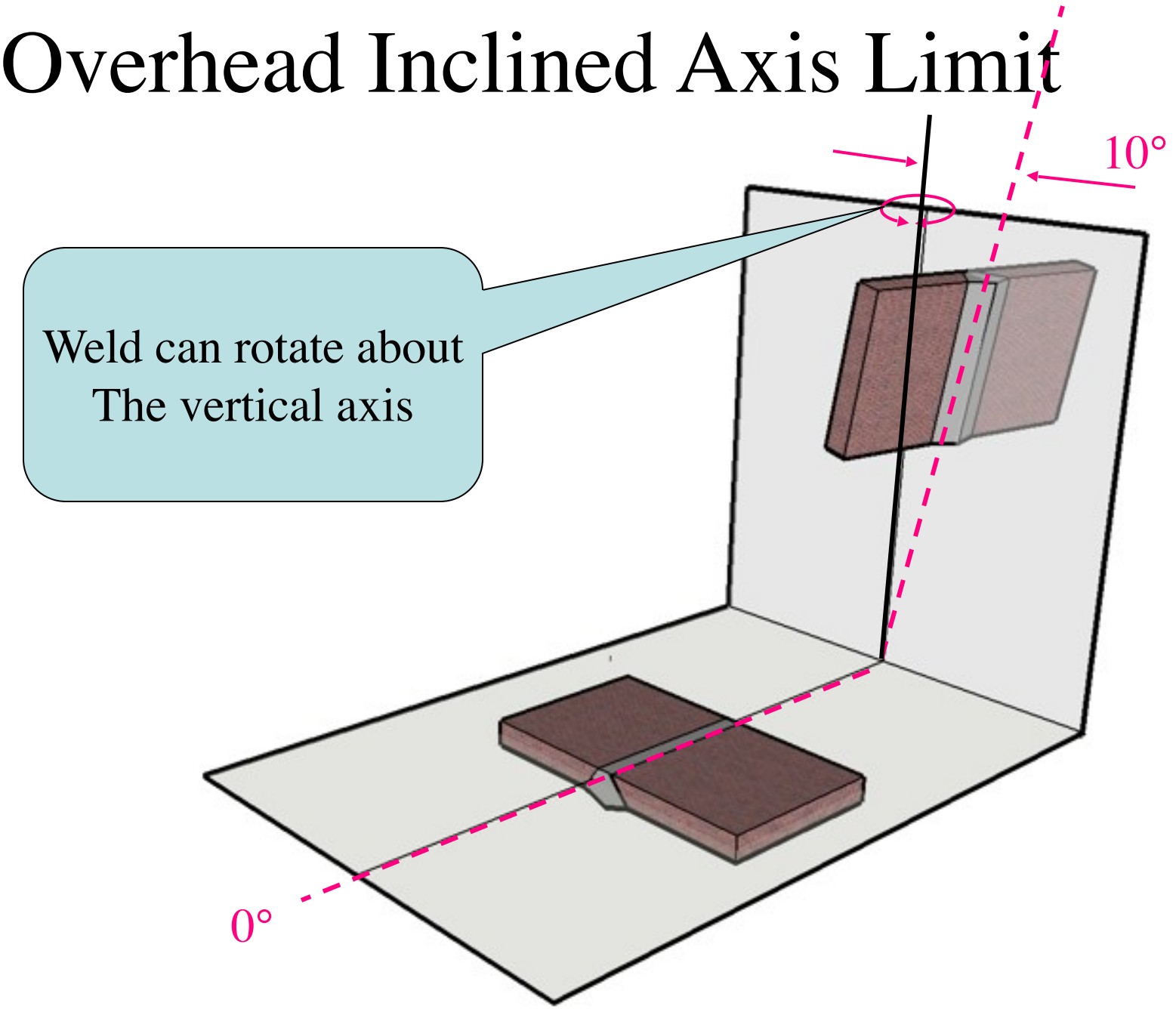
Overhead Inclined Axis Limit



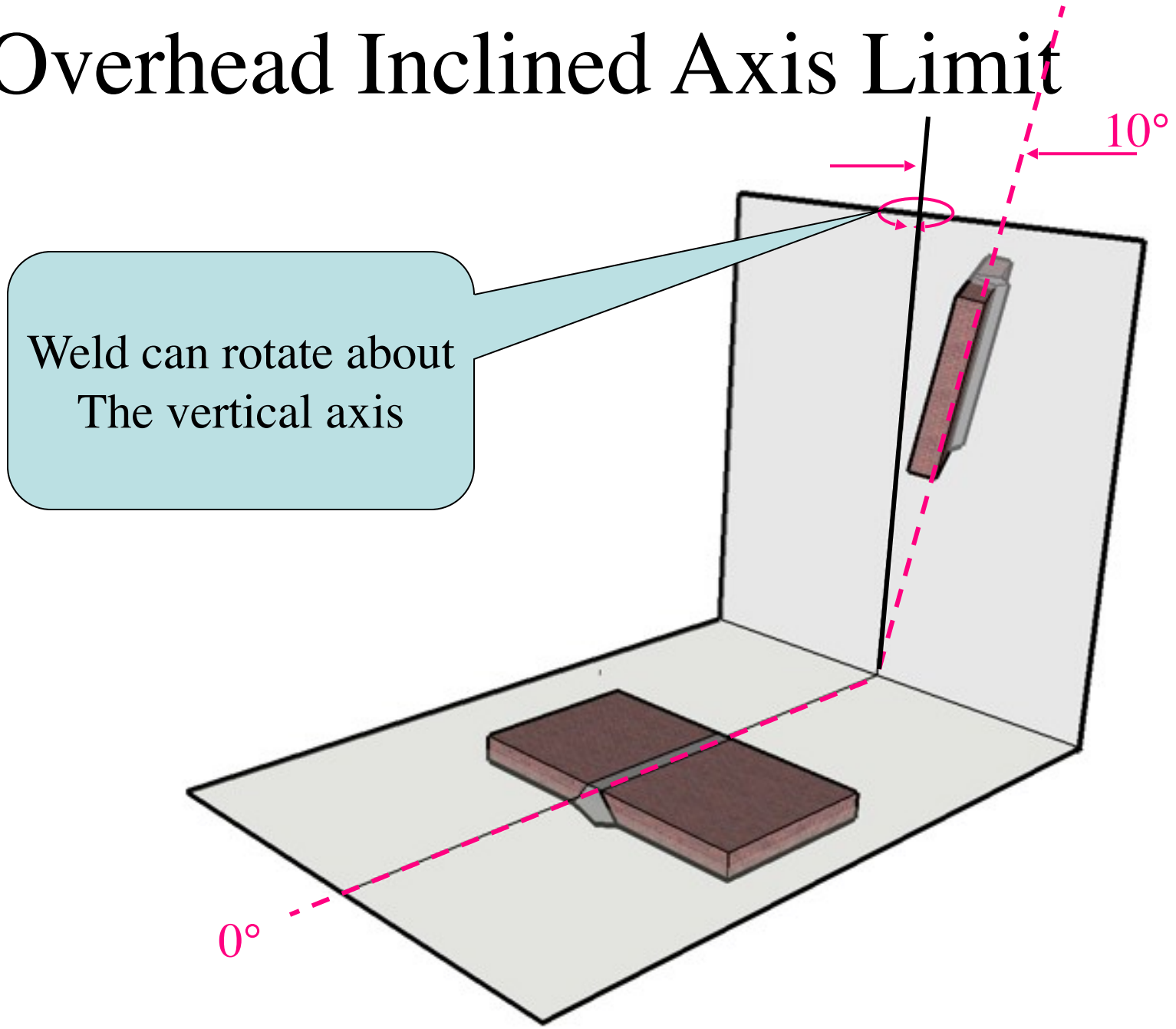
Overhead Inclined Axis Limit



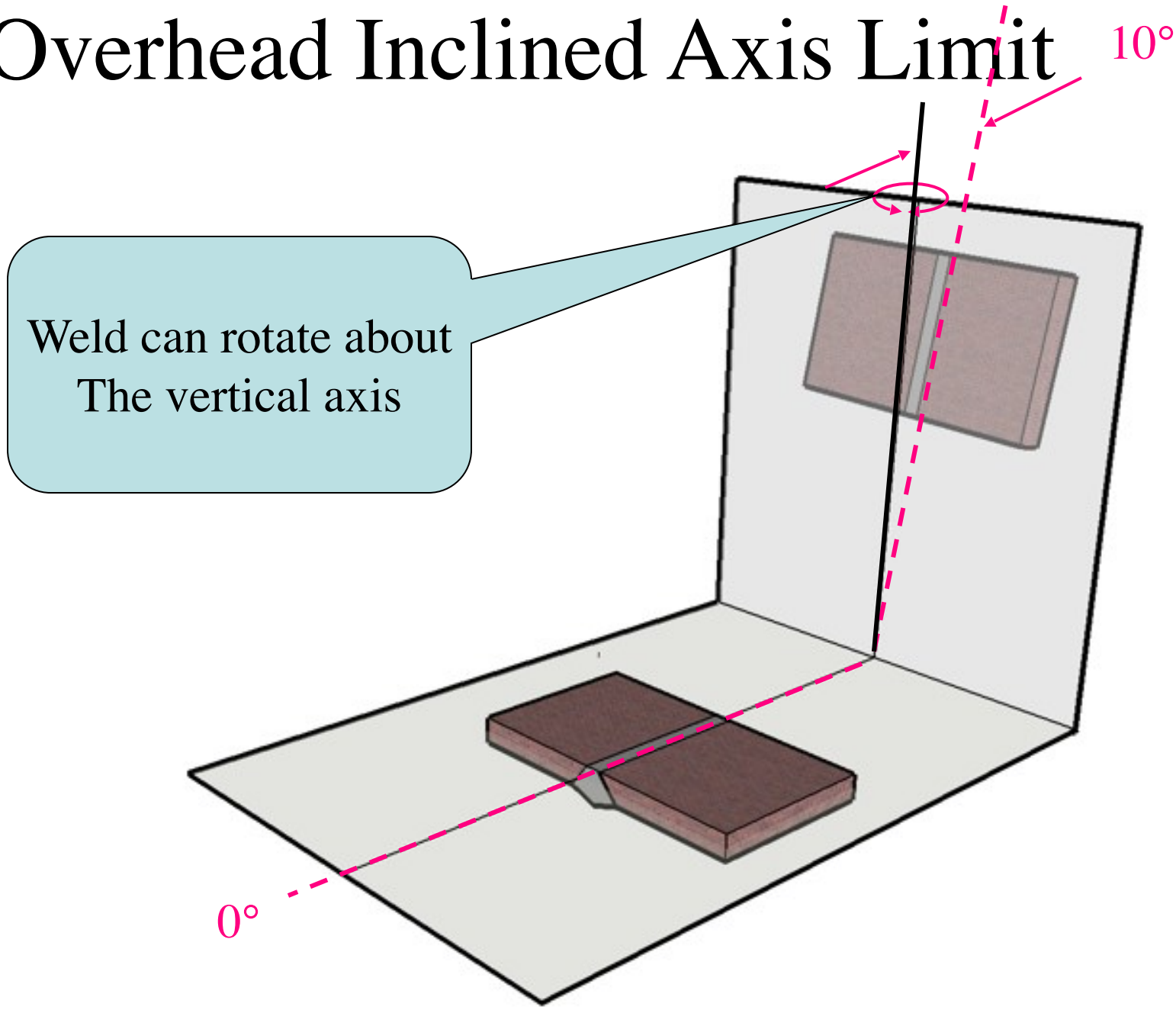
Overhead Inclined Axis Limit



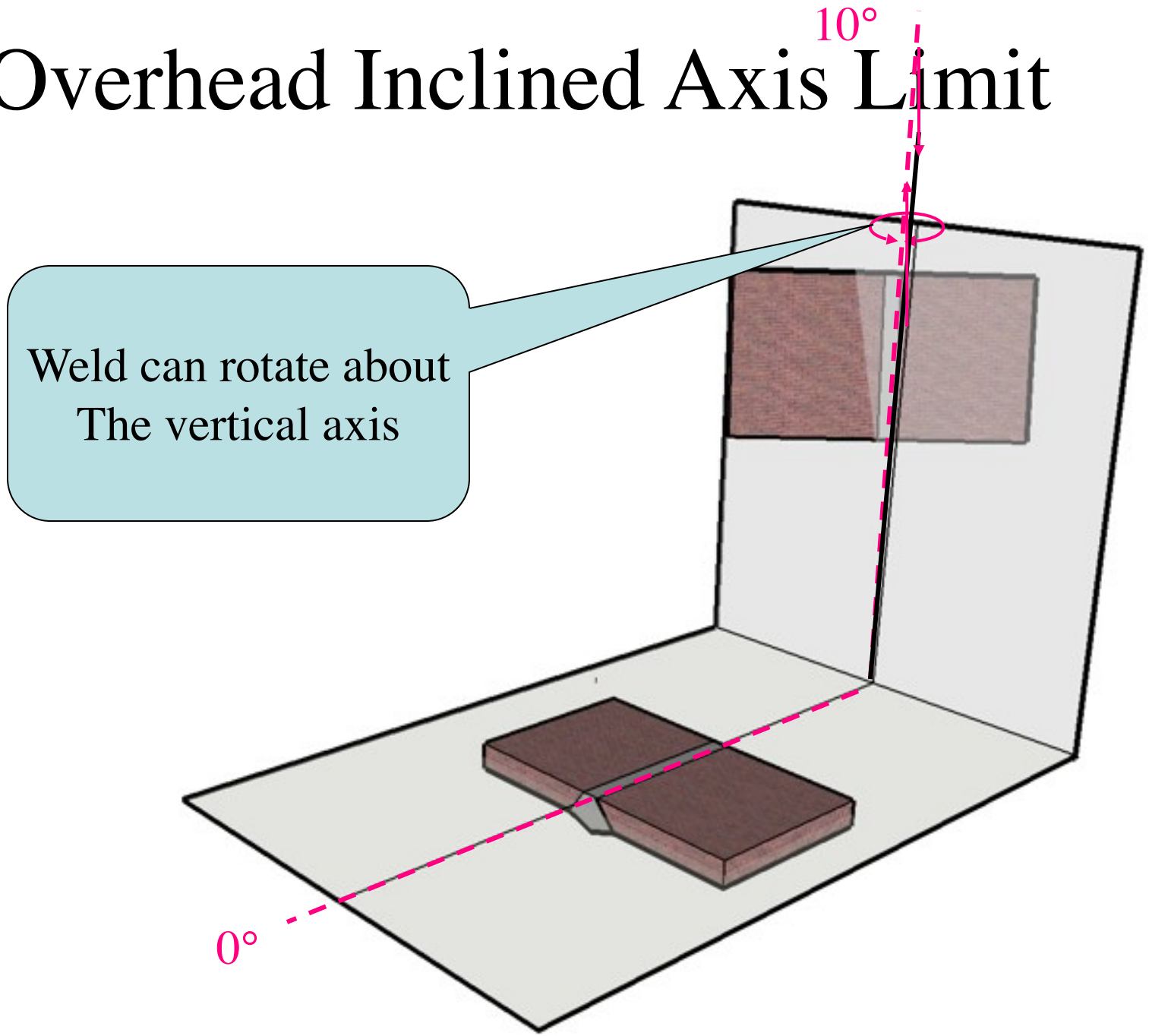
Overhead Inclined Axis Limit



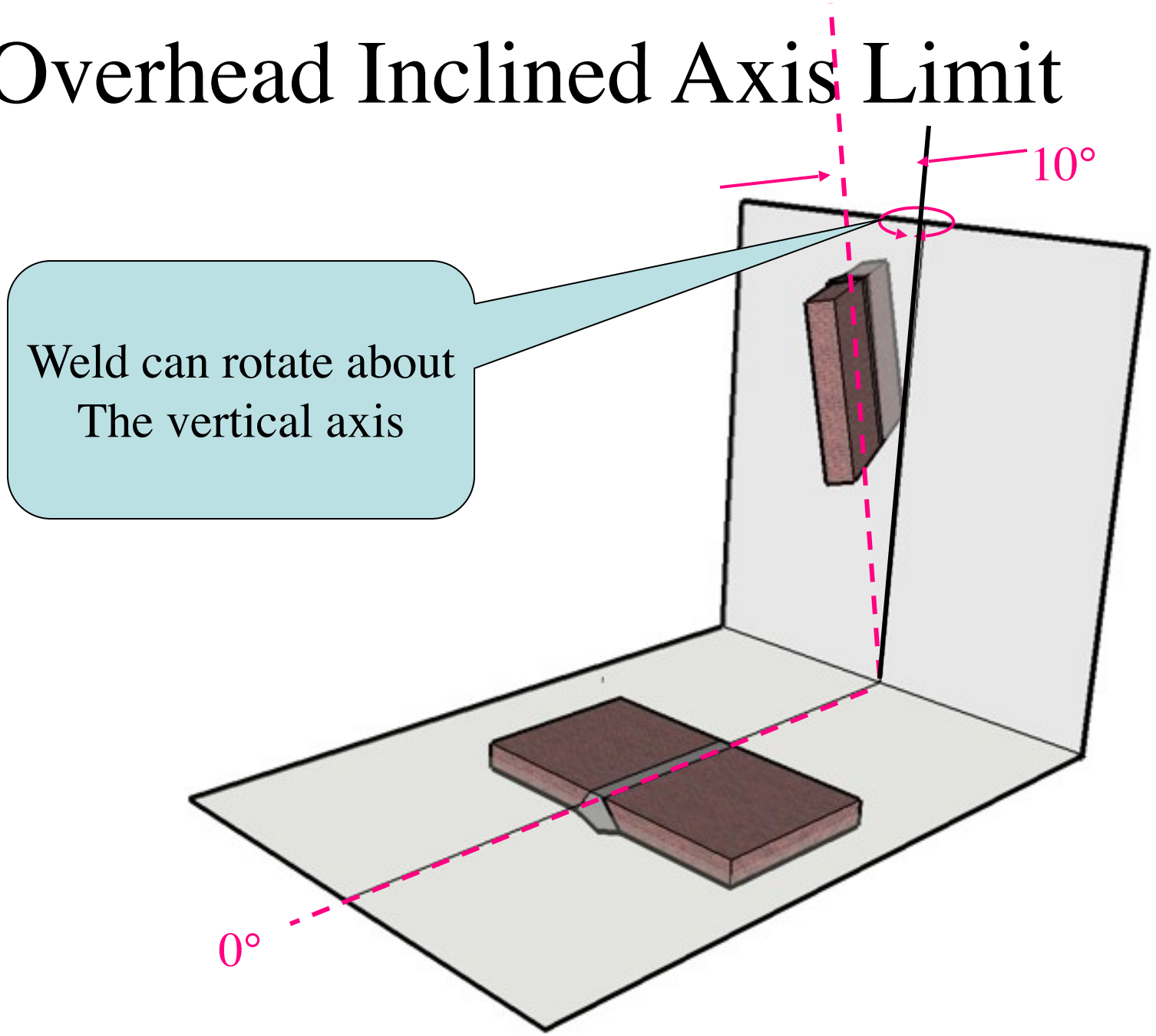
Overhead Inclined Axis Limit



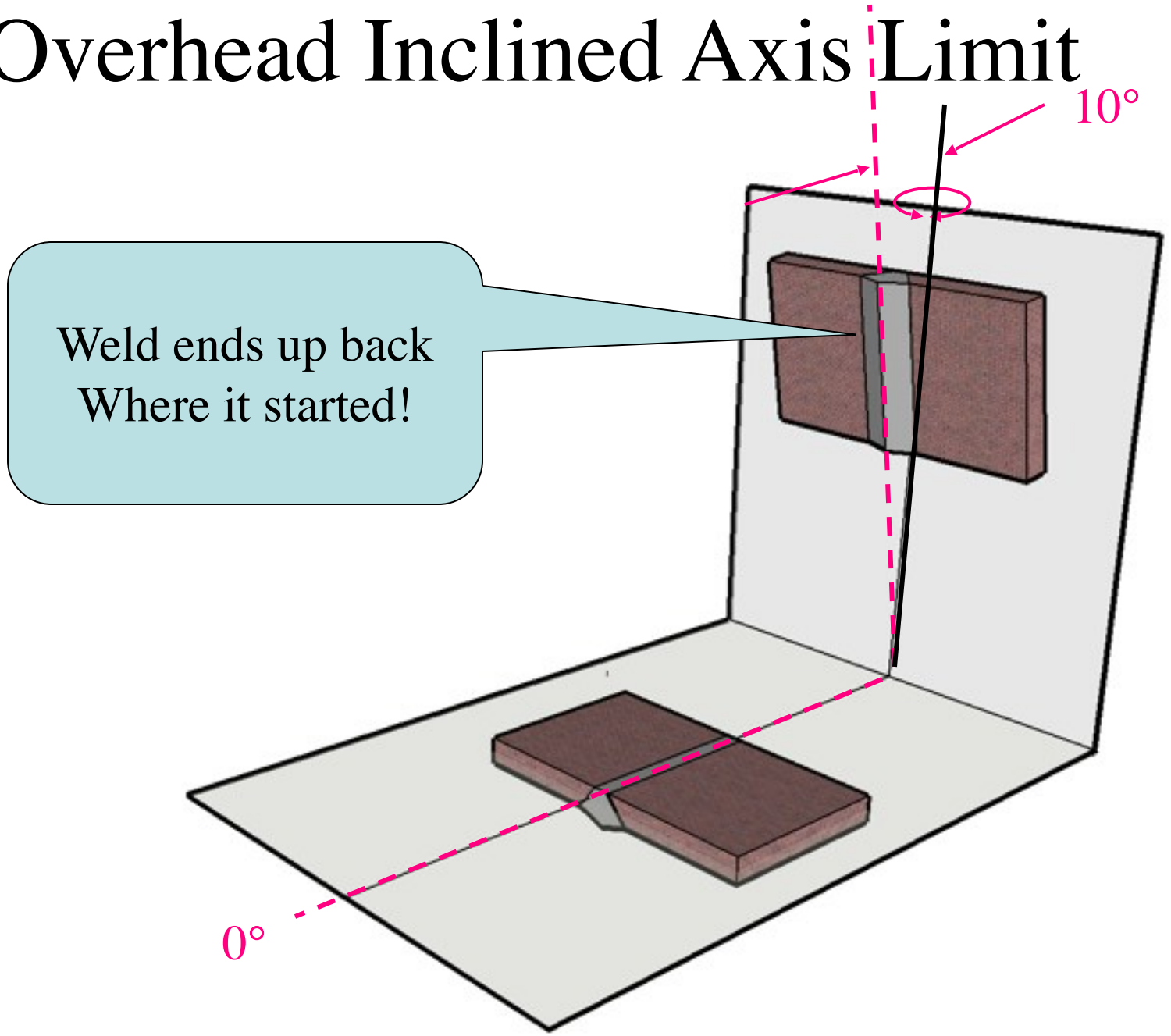
Overhead Inclined Axis Limit



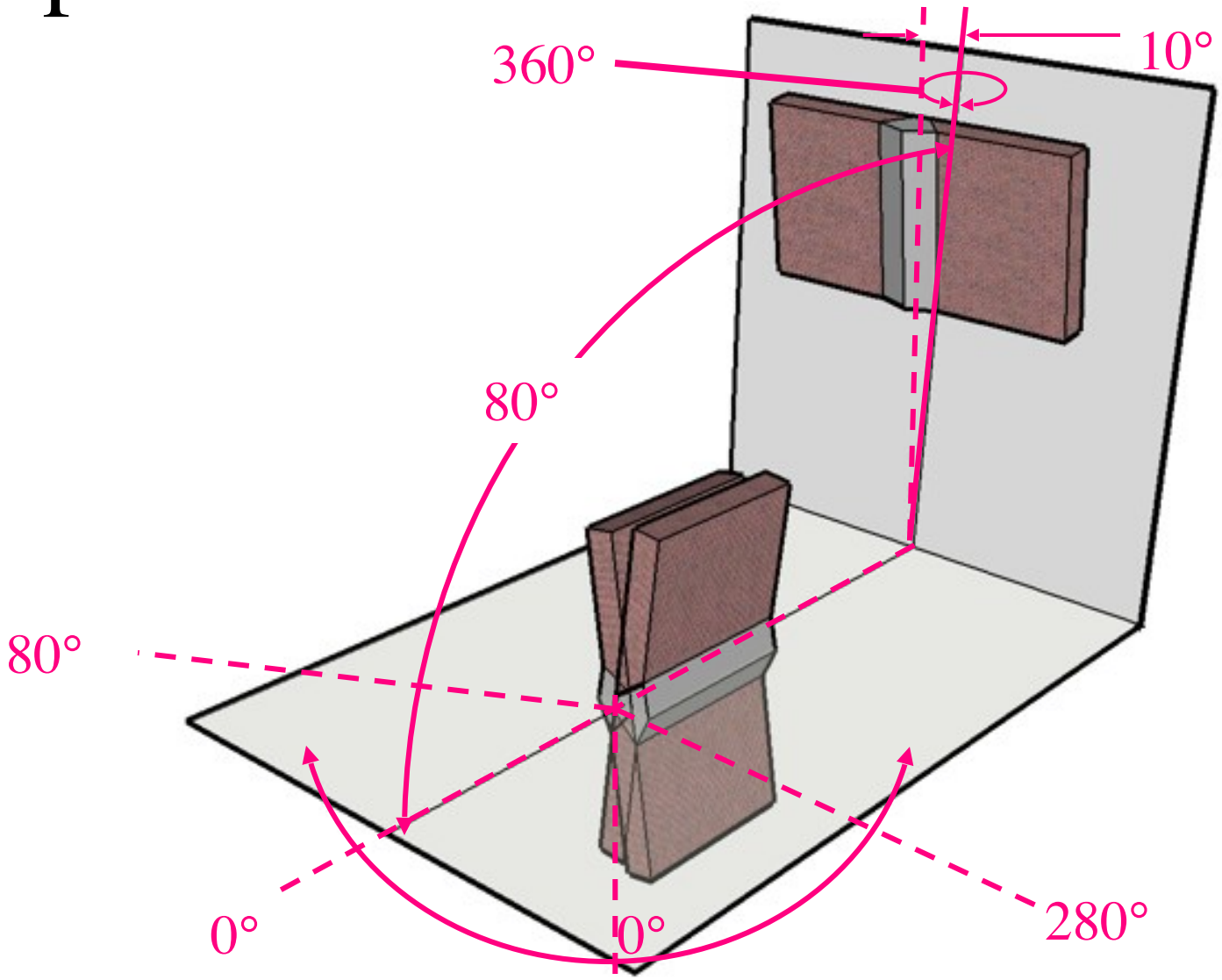
Overhead Inclined Axis Limit



Overhead Inclined Axis Limit



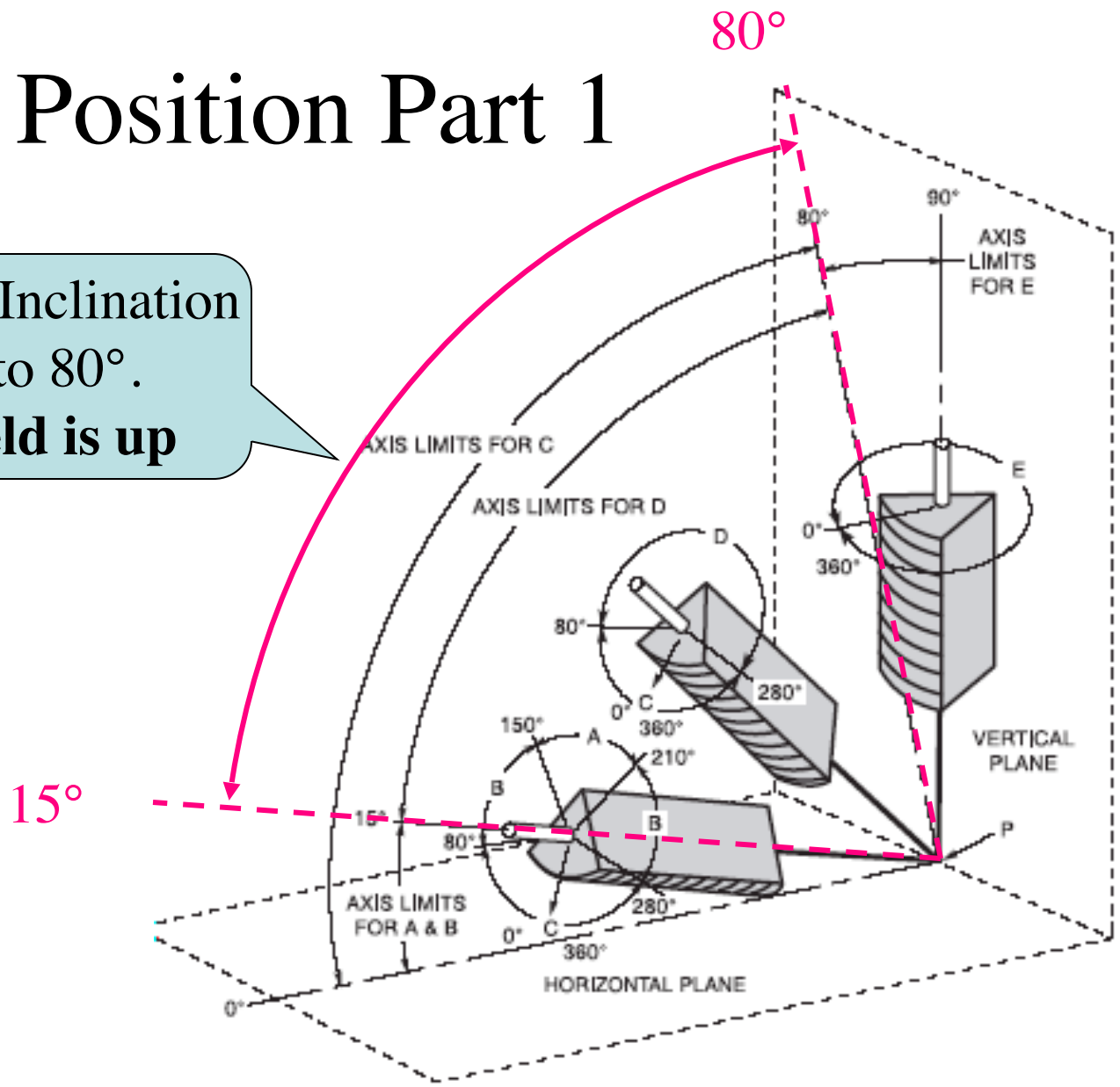
Composite Overhead Position Limits



Overhead ≠ 4G !!!!

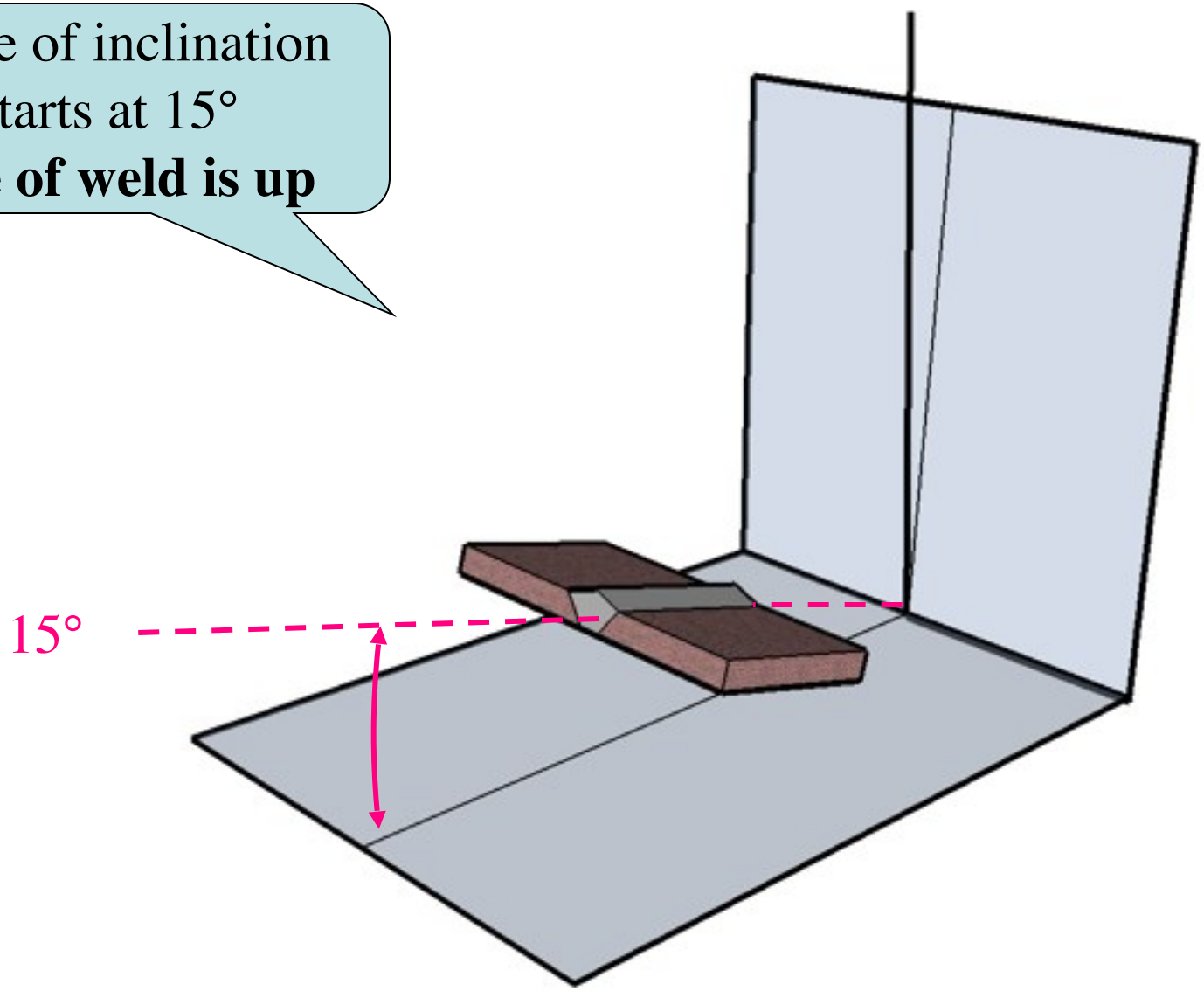
Vertical Position Part 1

65° Range of Inclination
From 15 to 80°.
Face of weld is up

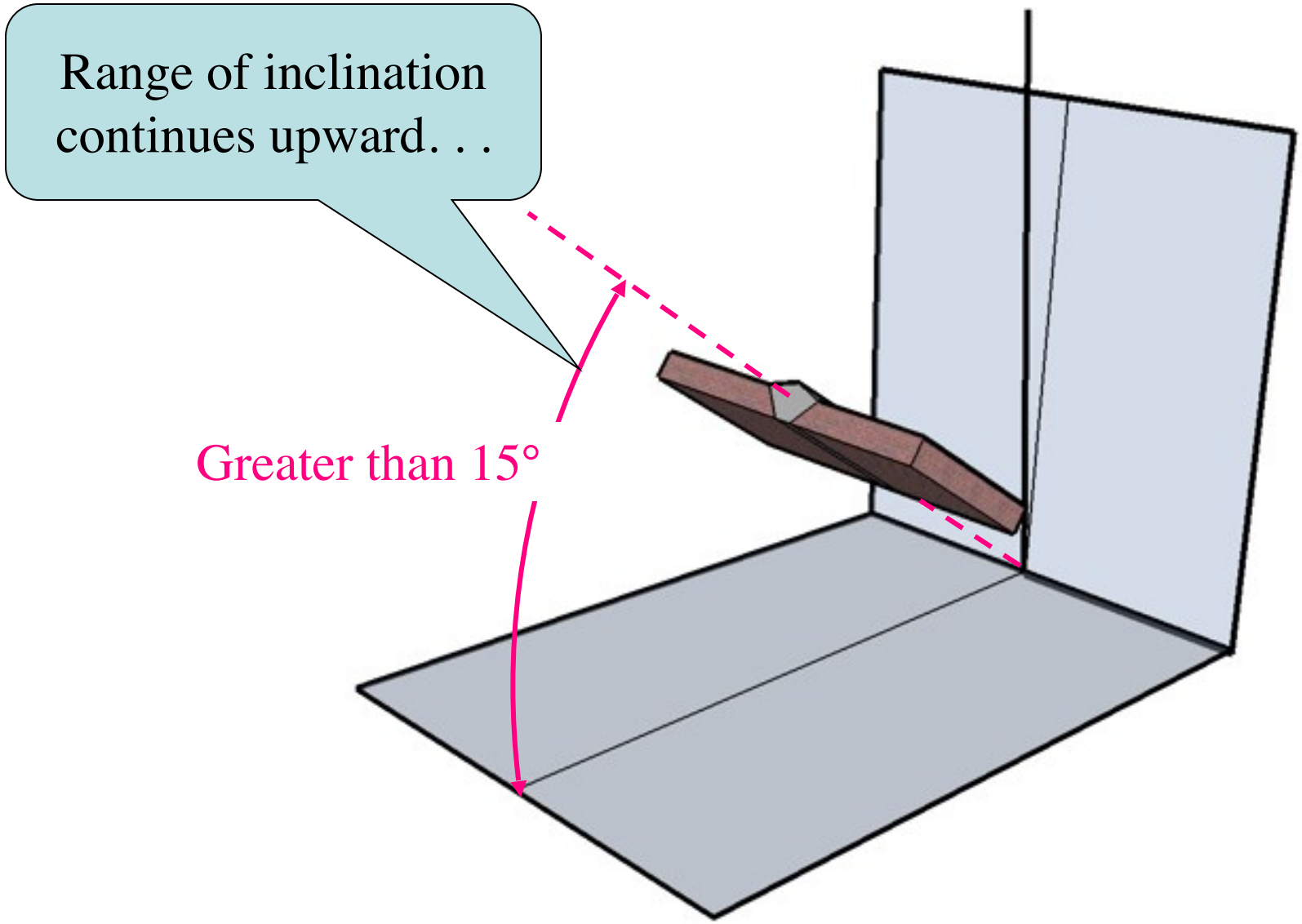


Vertical Position Part 1

Range of inclination
Starts at 15°
Face of weld is up

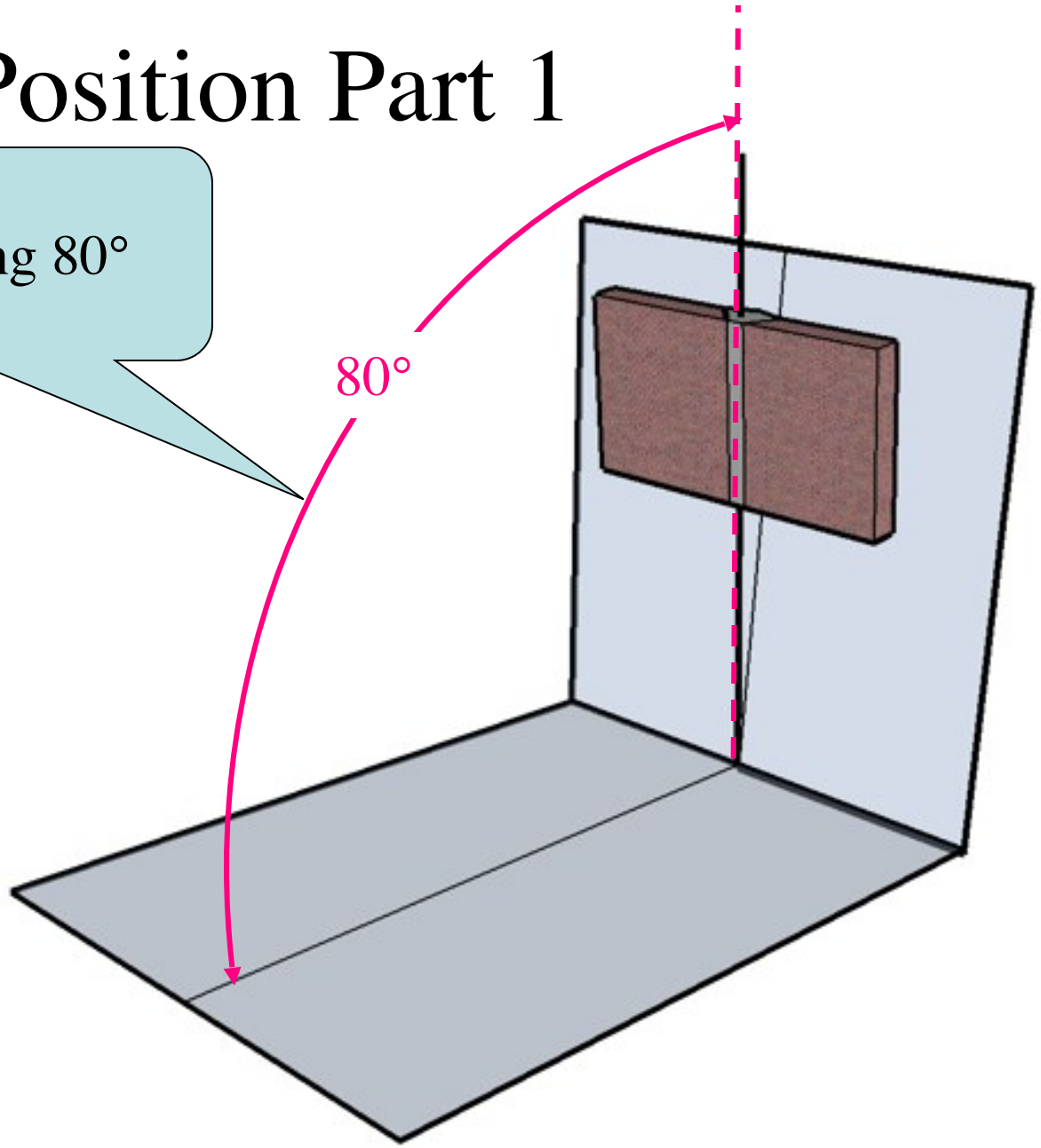


Vertical Position Part 1



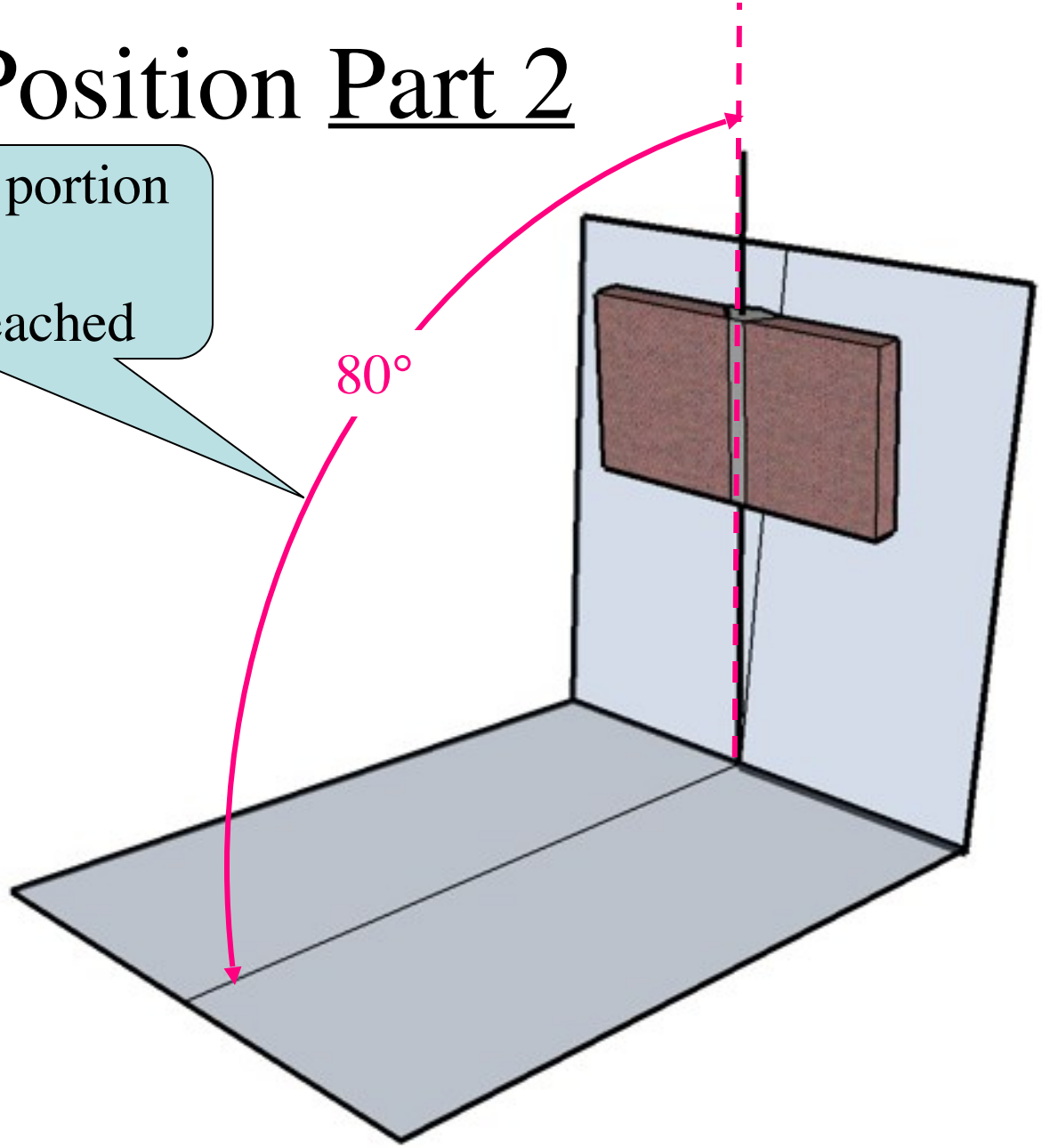
Vertical Position Part 1

Until reaching 80°



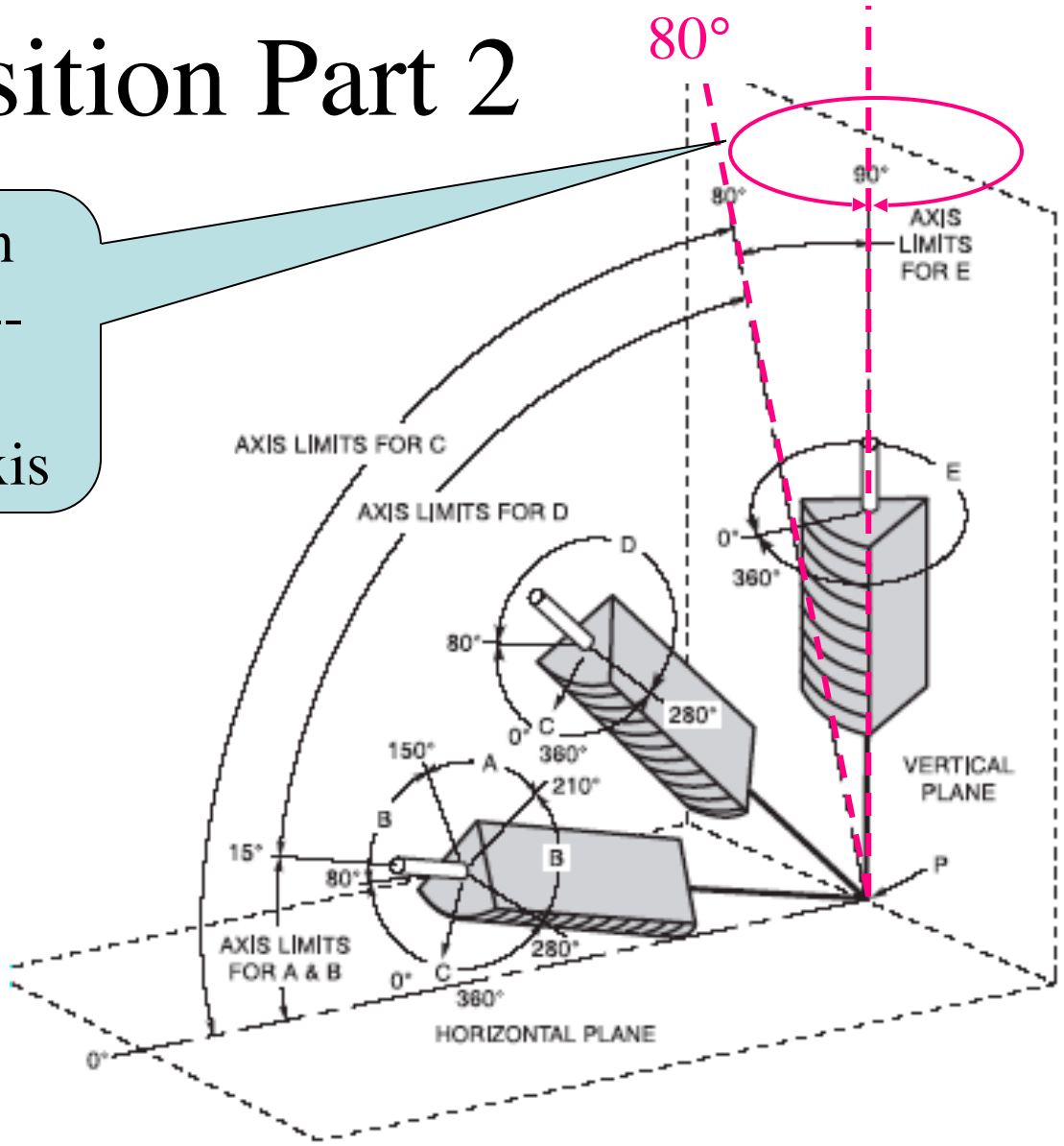
Vertical Position Part 2

When the “E” portion of the diagram is reached



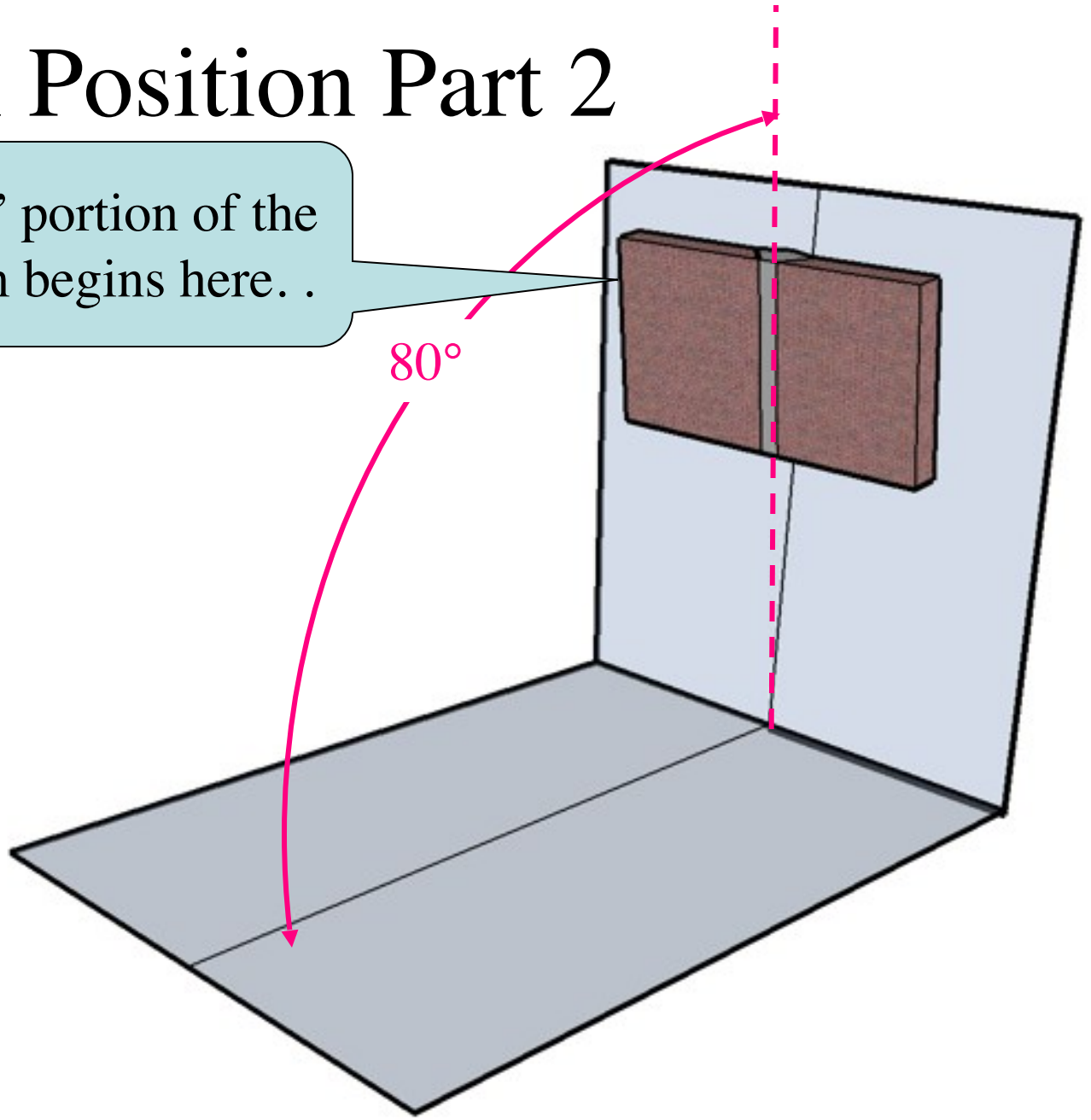
Vertical Position Part 2

The “E” portion of the diagram -- 360° Rotation About vertical axis

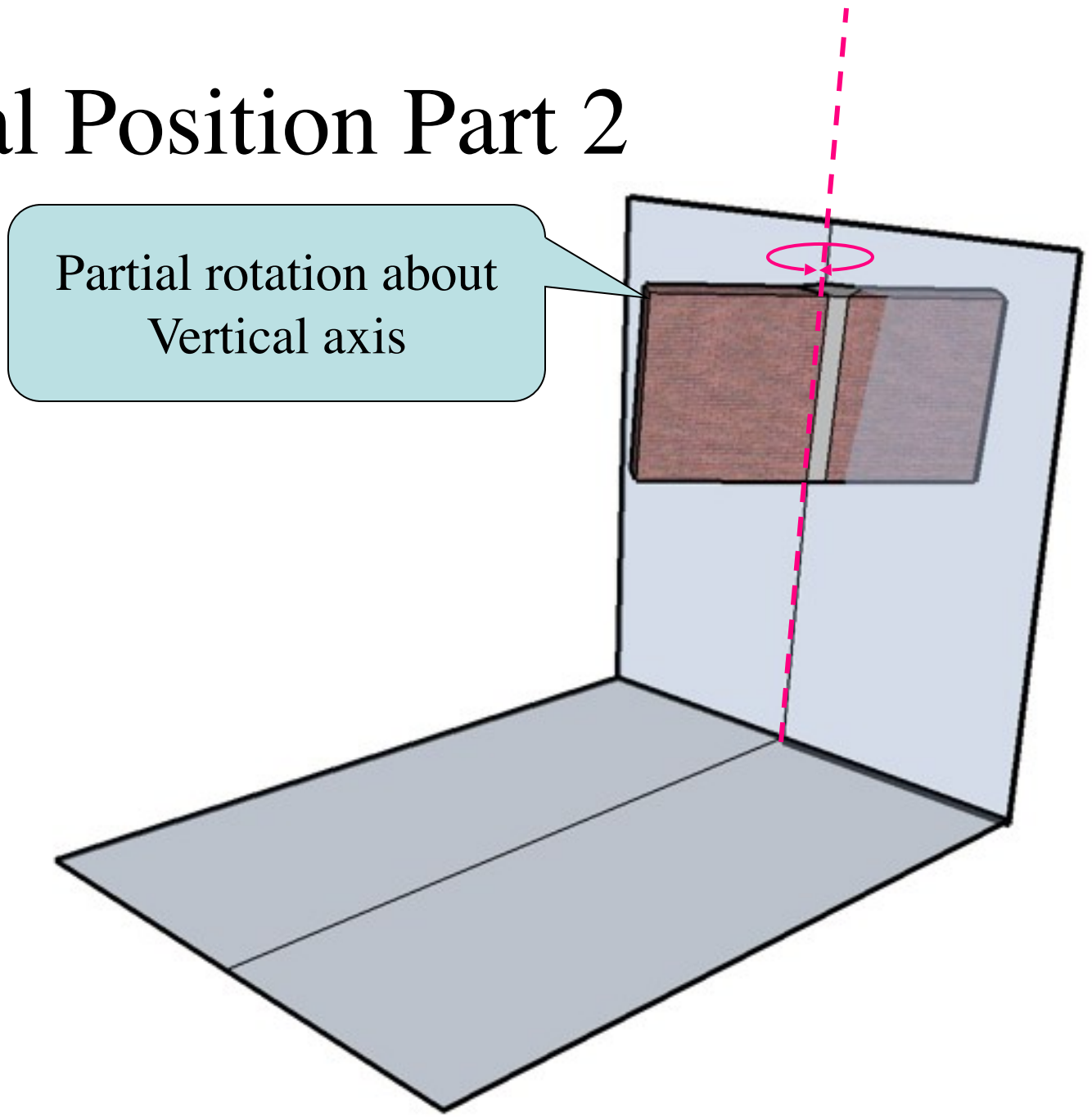


Vertical Position Part 2

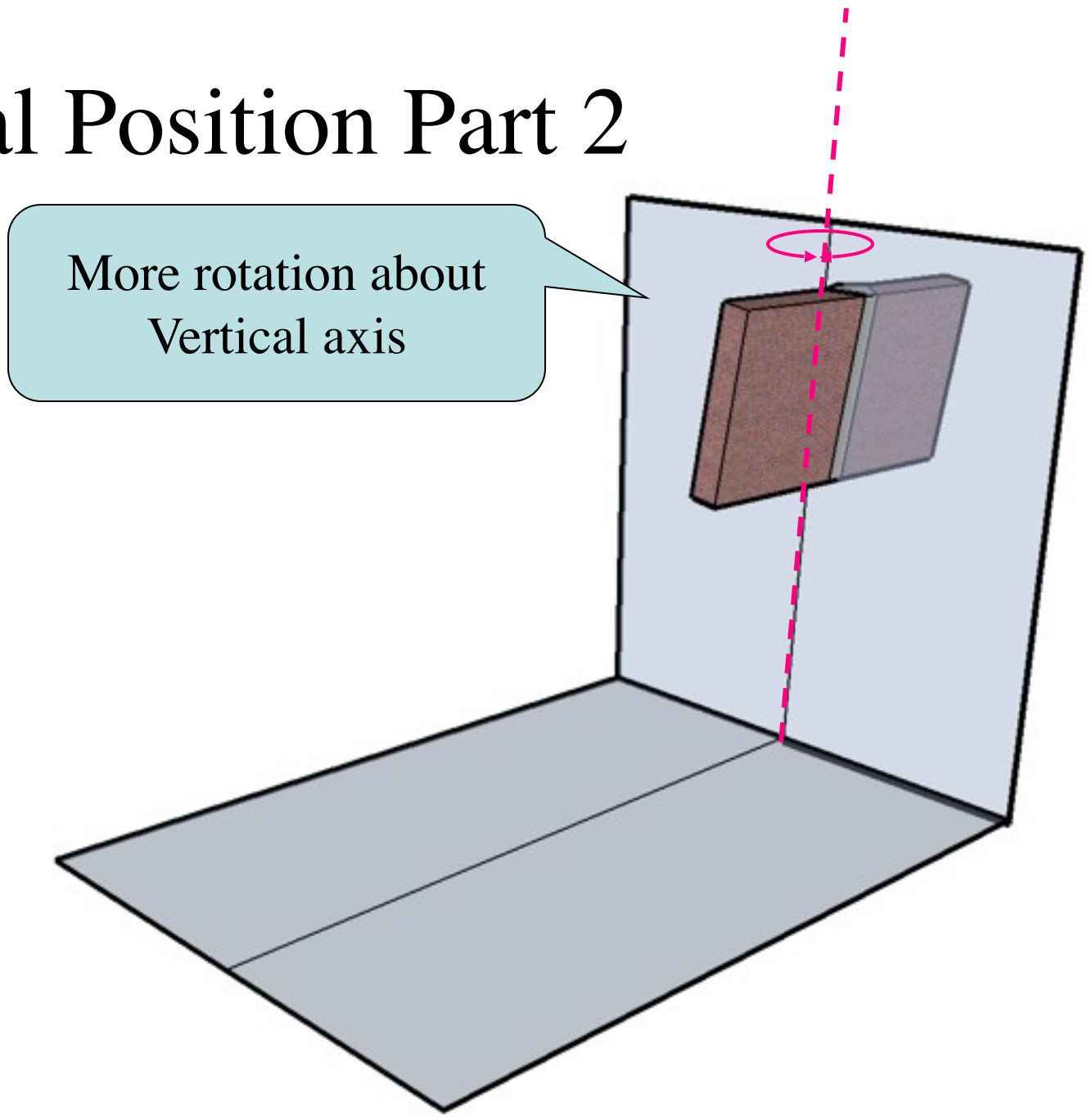
The “E” portion of the diagram begins here. .



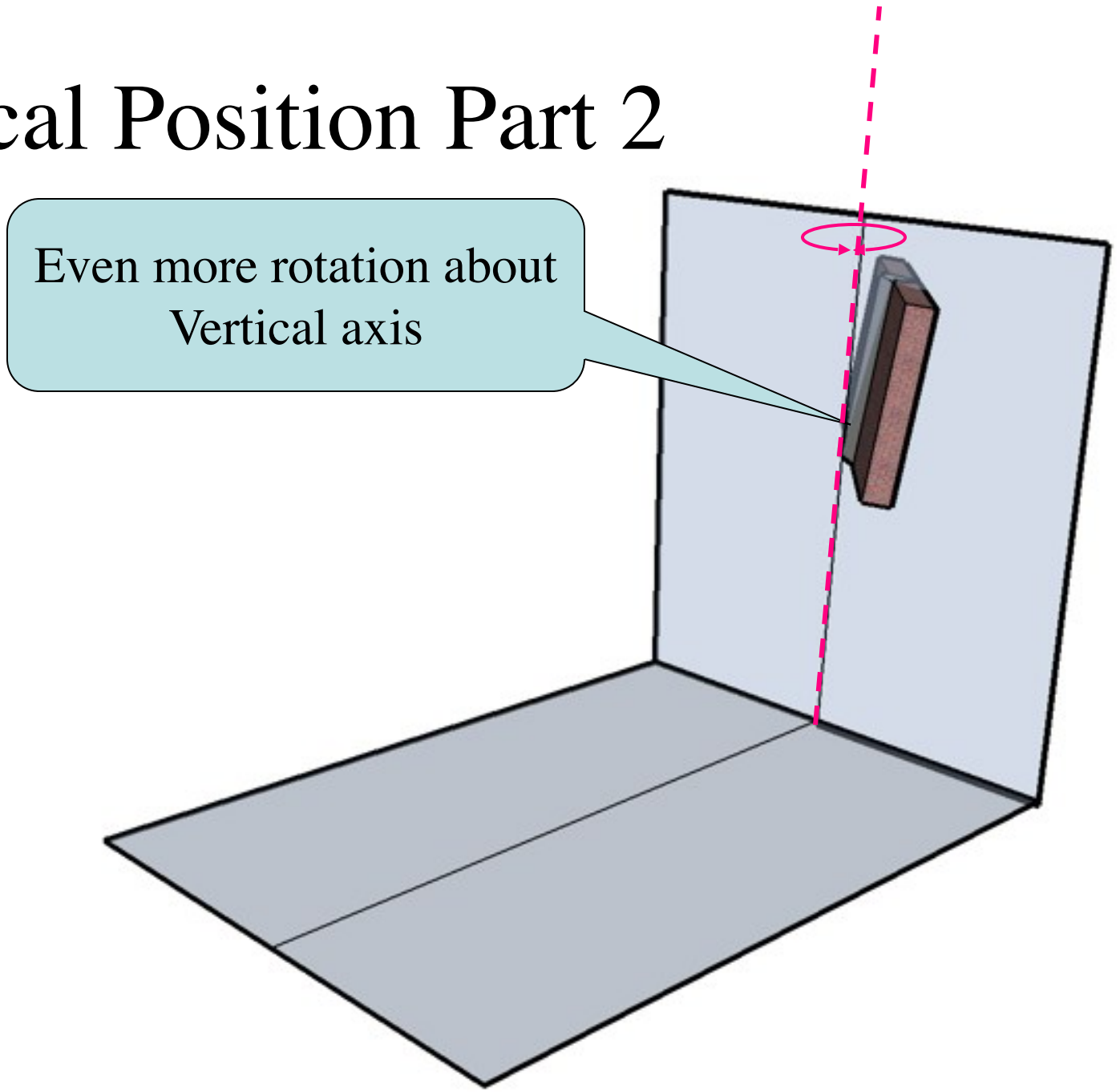
Vertical Position Part 2



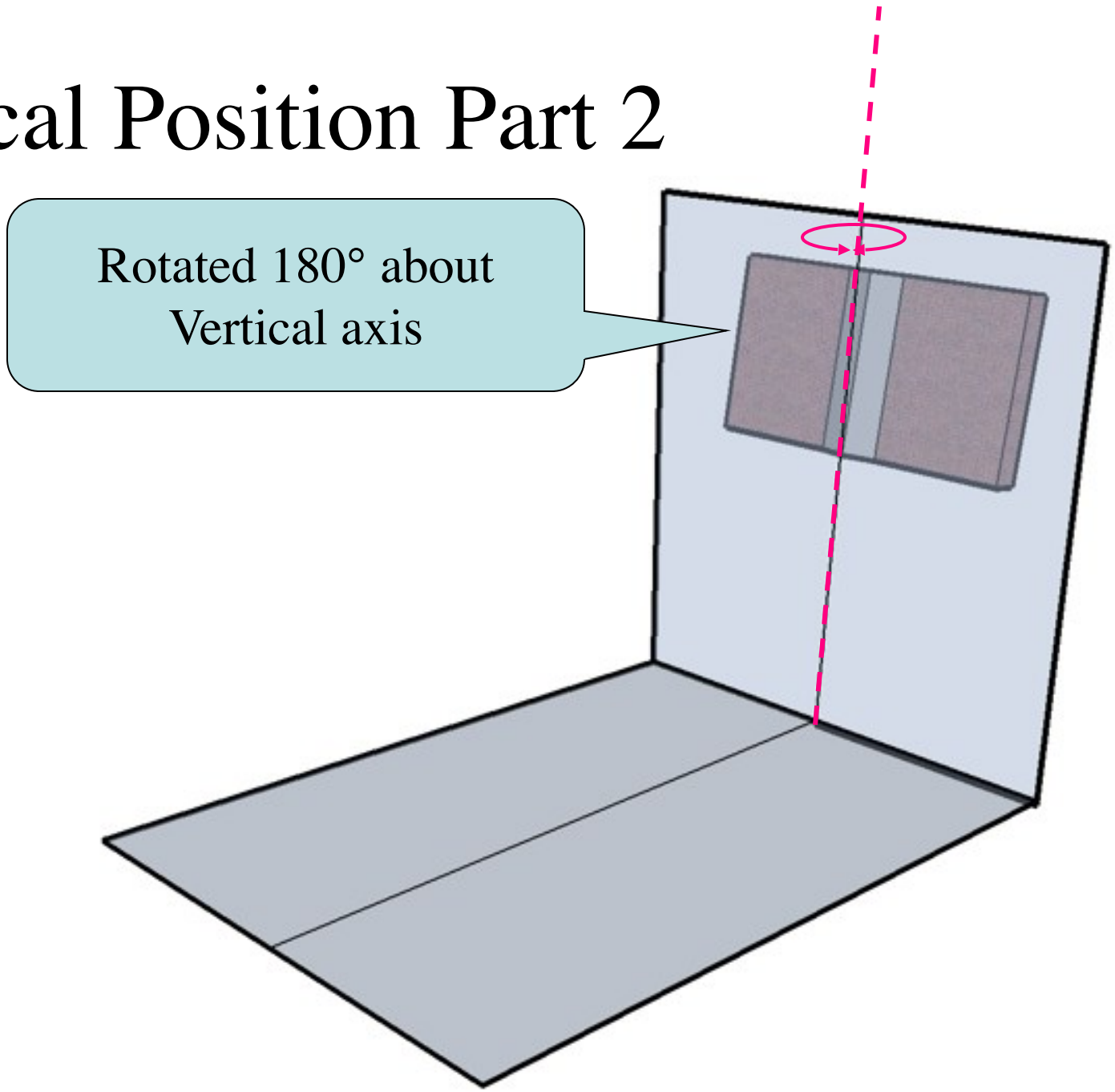
Vertical Position Part 2



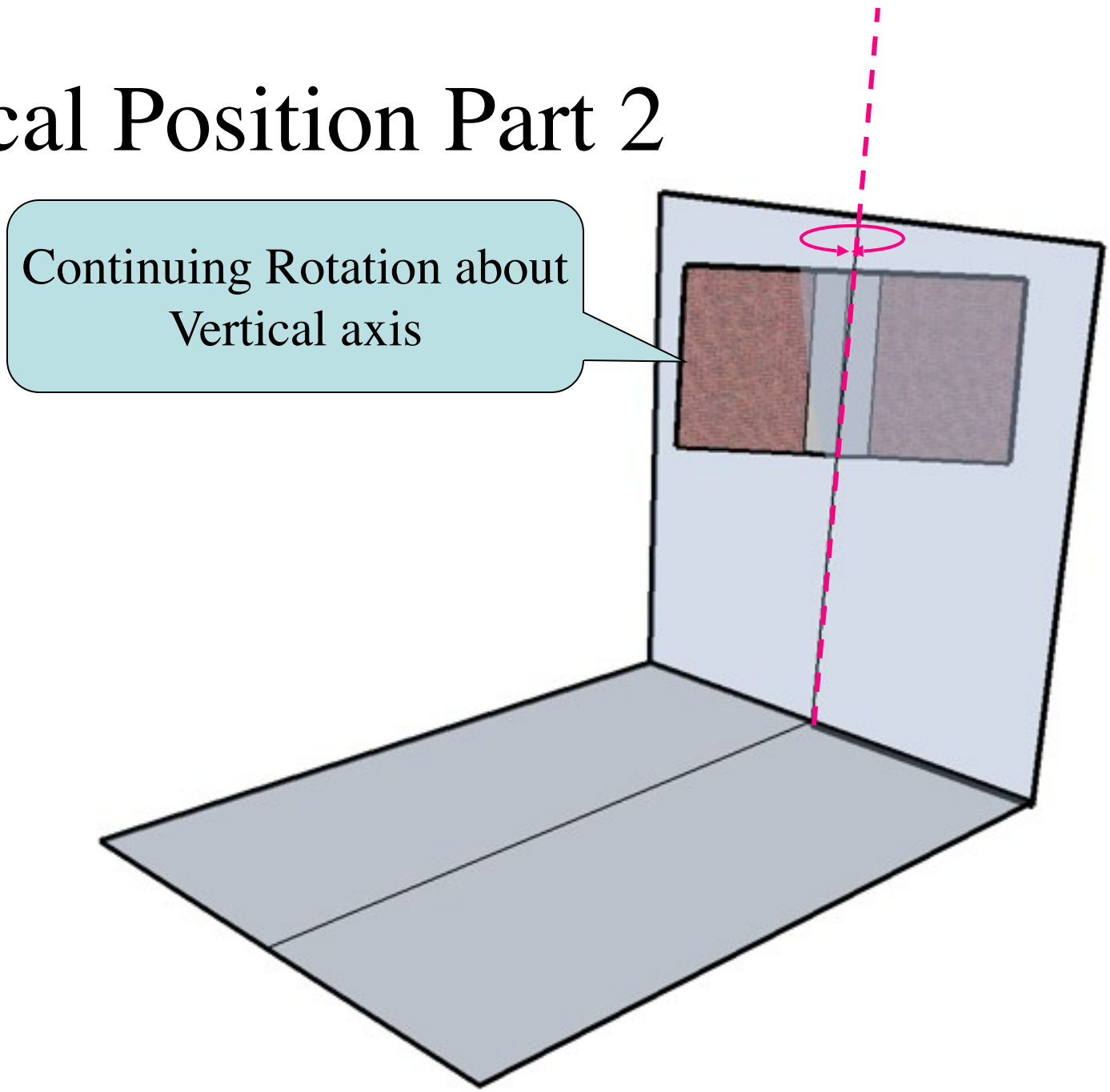
Vertical Position Part 2



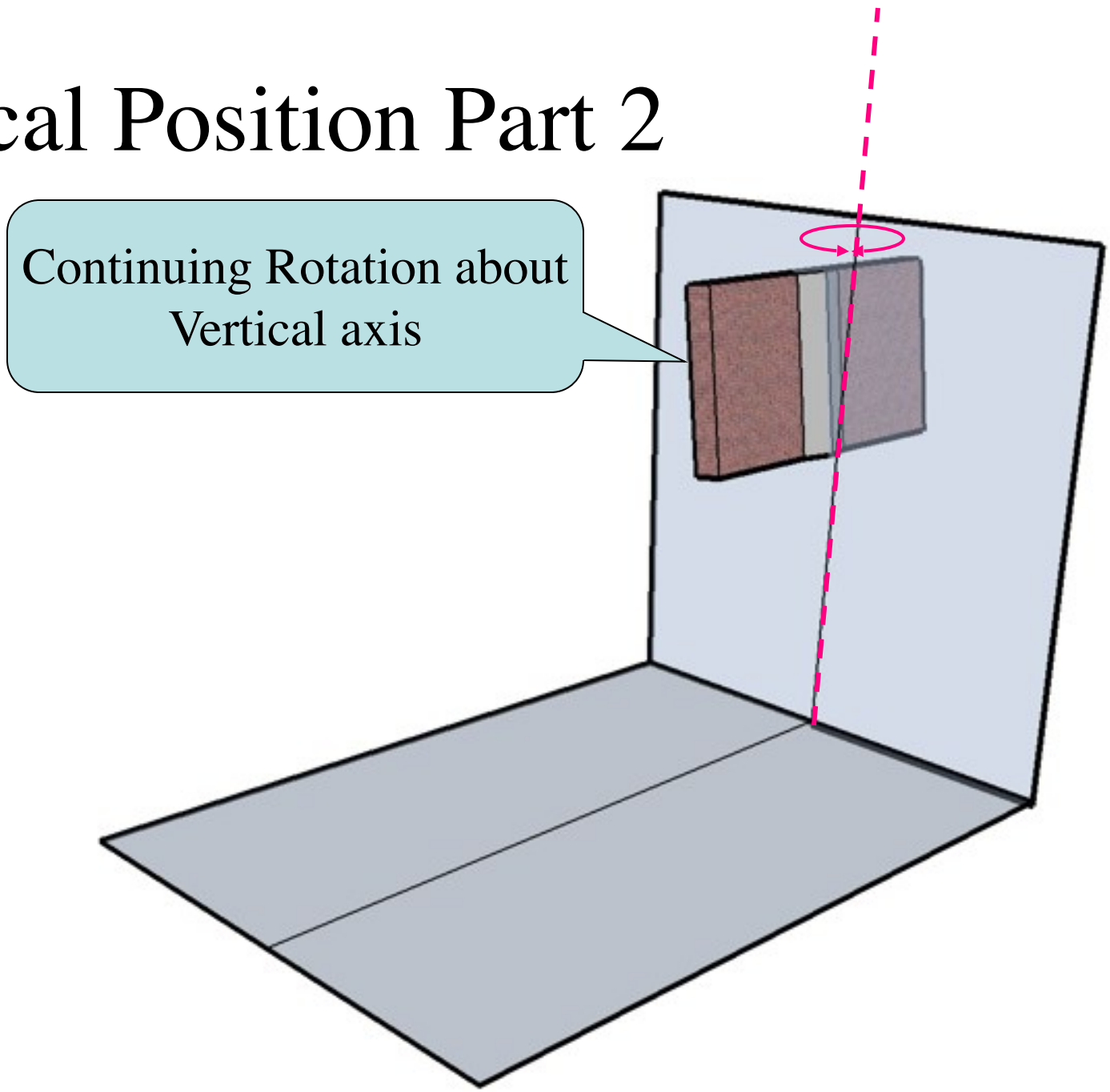
Vertical Position Part 2



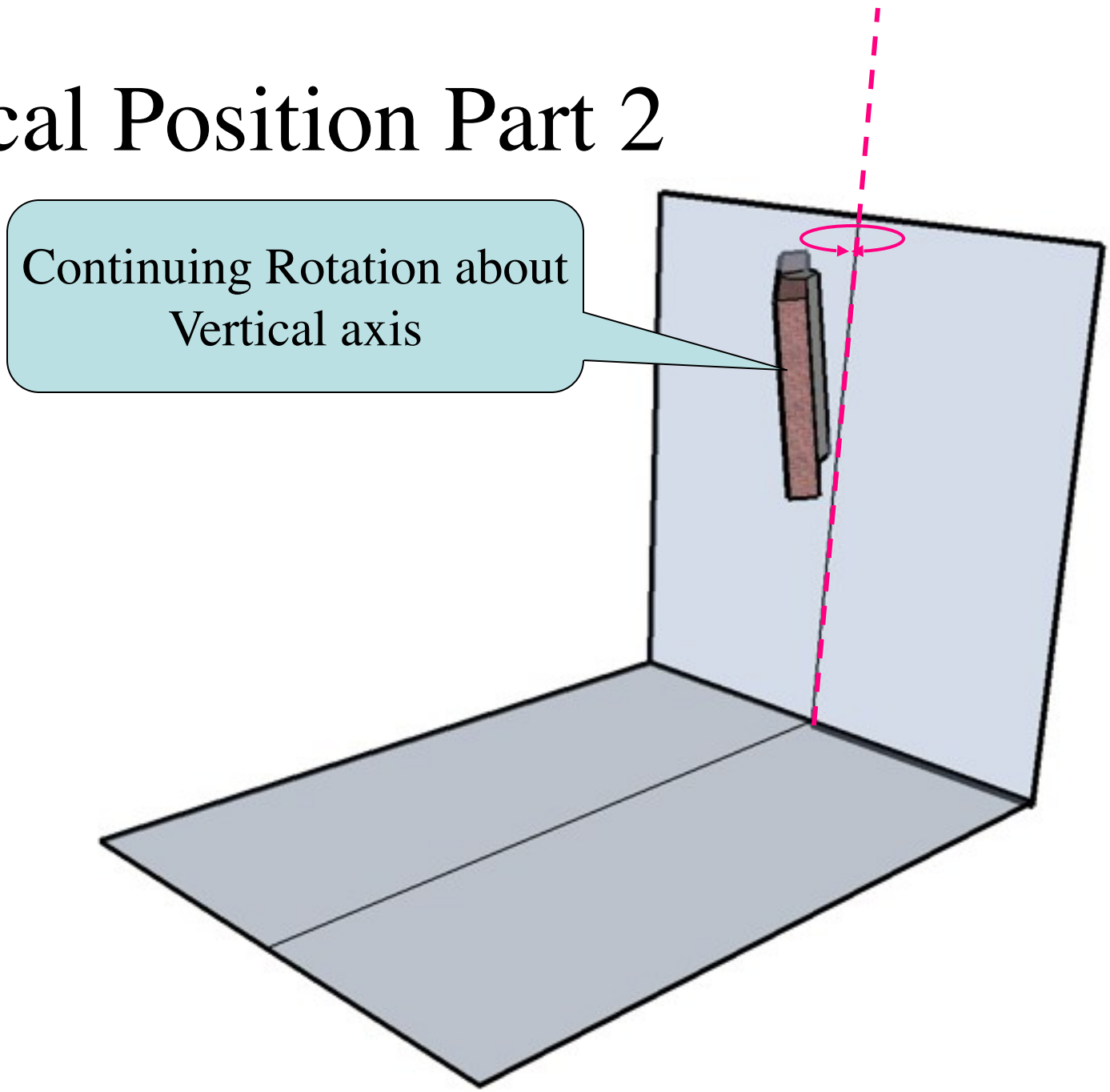
Vertical Position Part 2



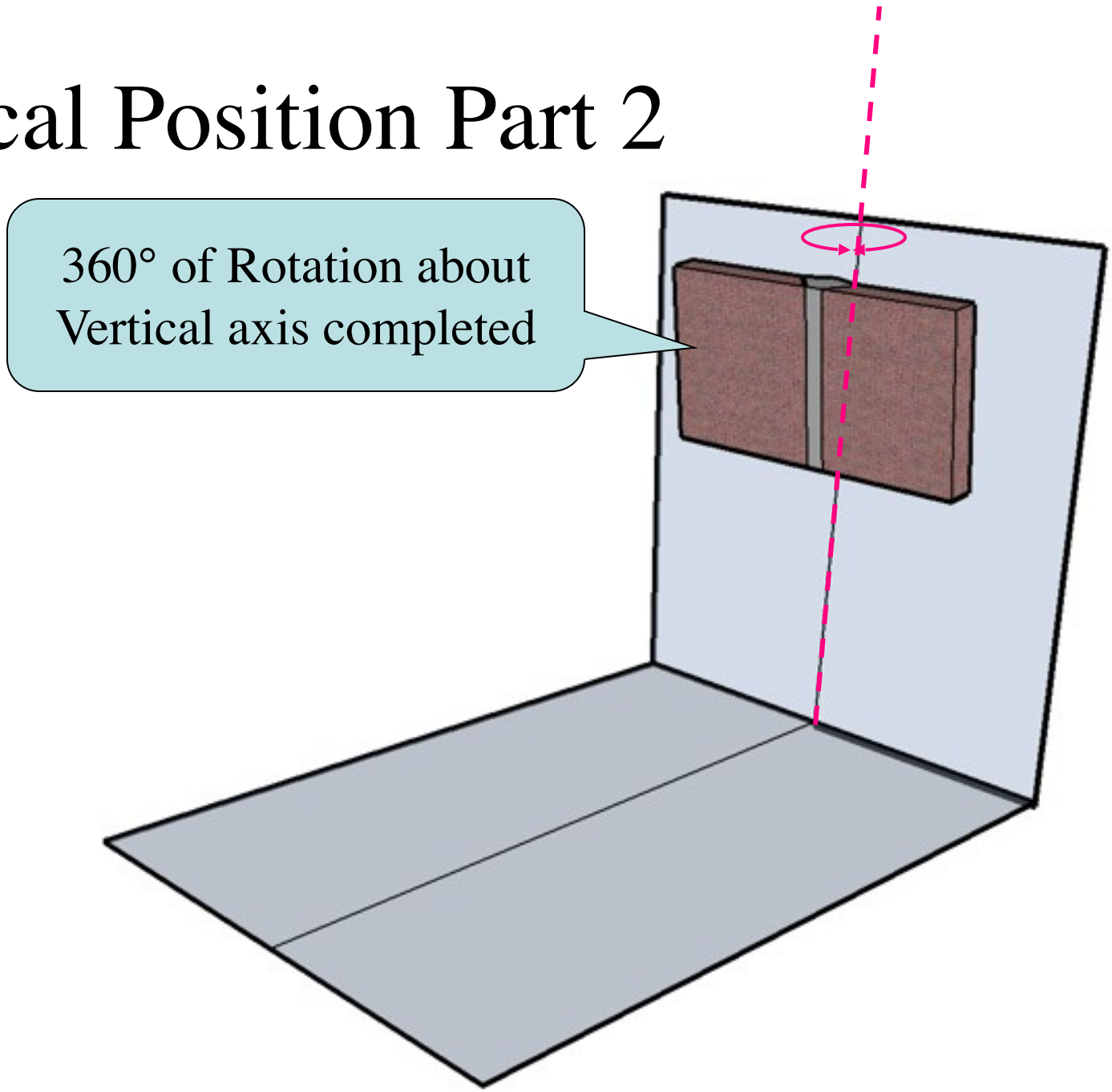
Vertical Position Part 2



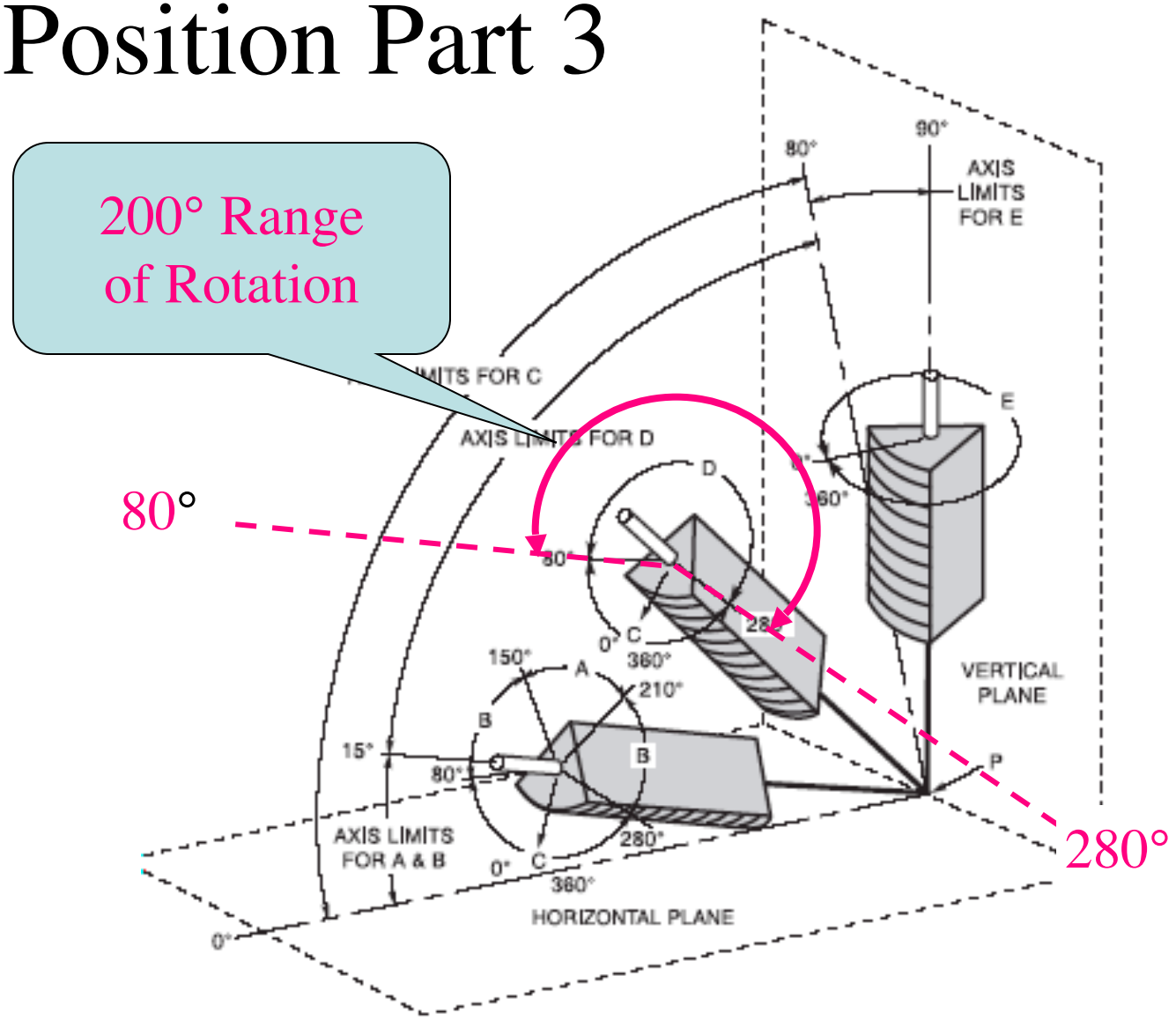
Vertical Position Part 2



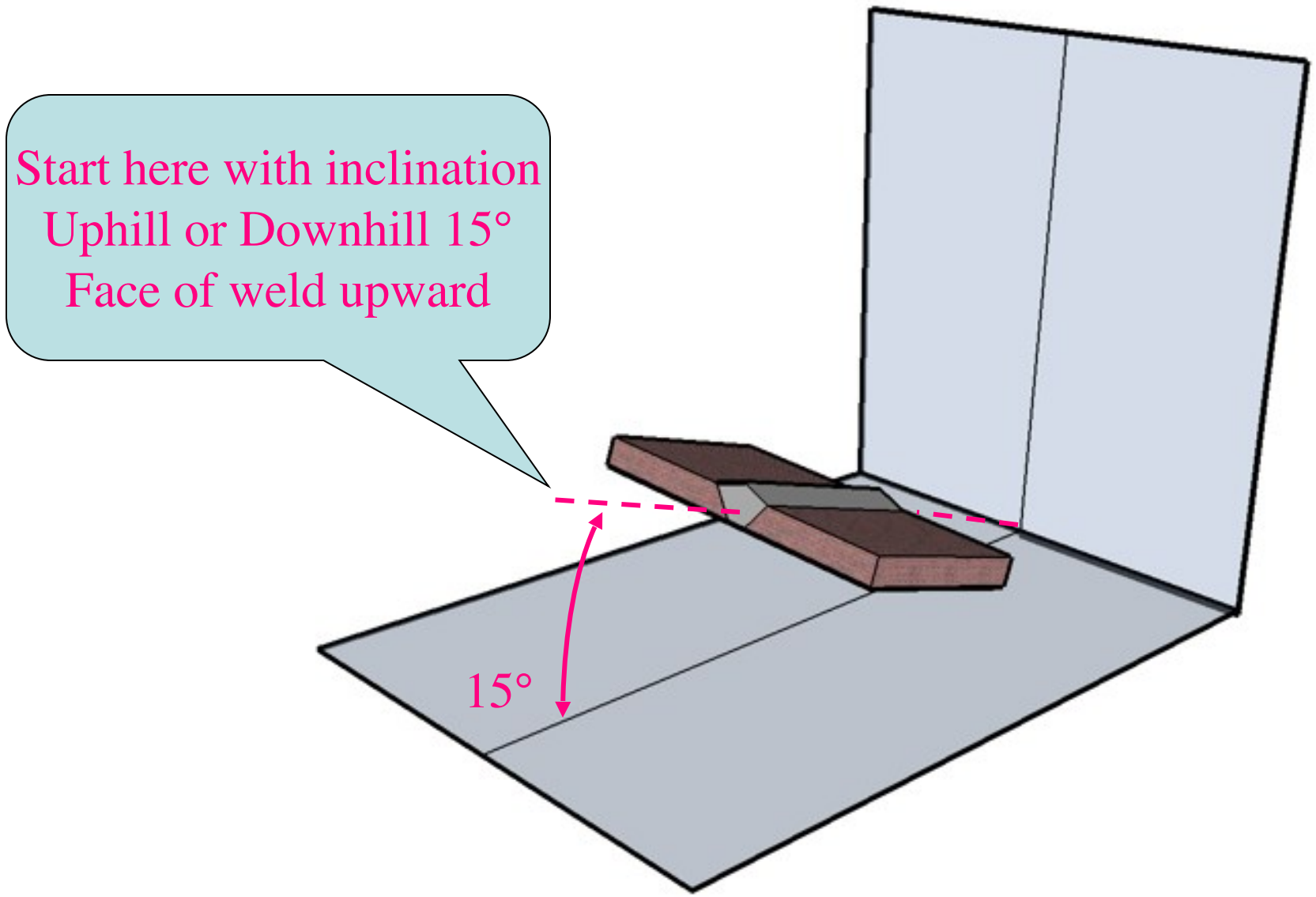
Vertical Position Part 2



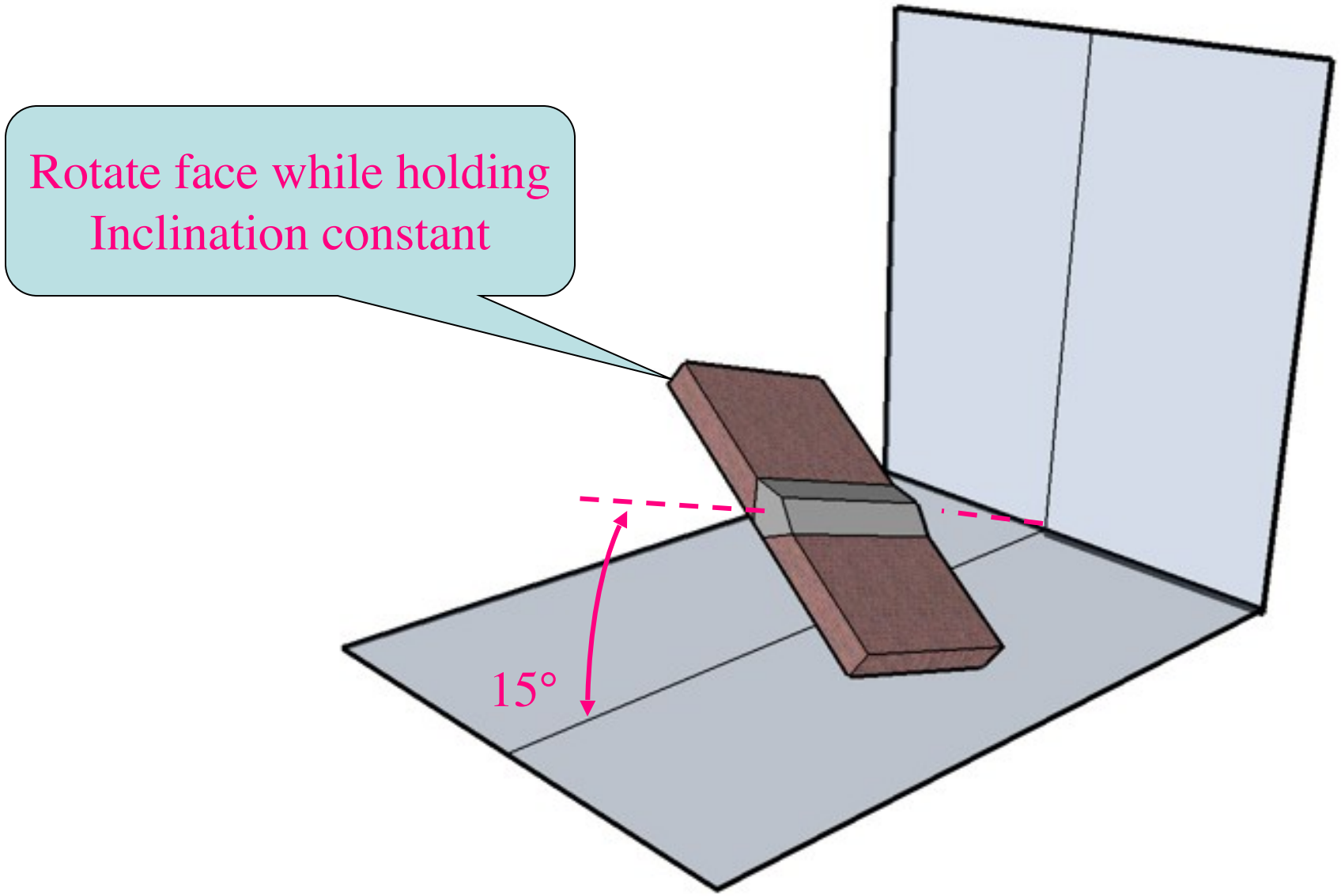
Vertical Position Part 3



Vertical Position Part 3

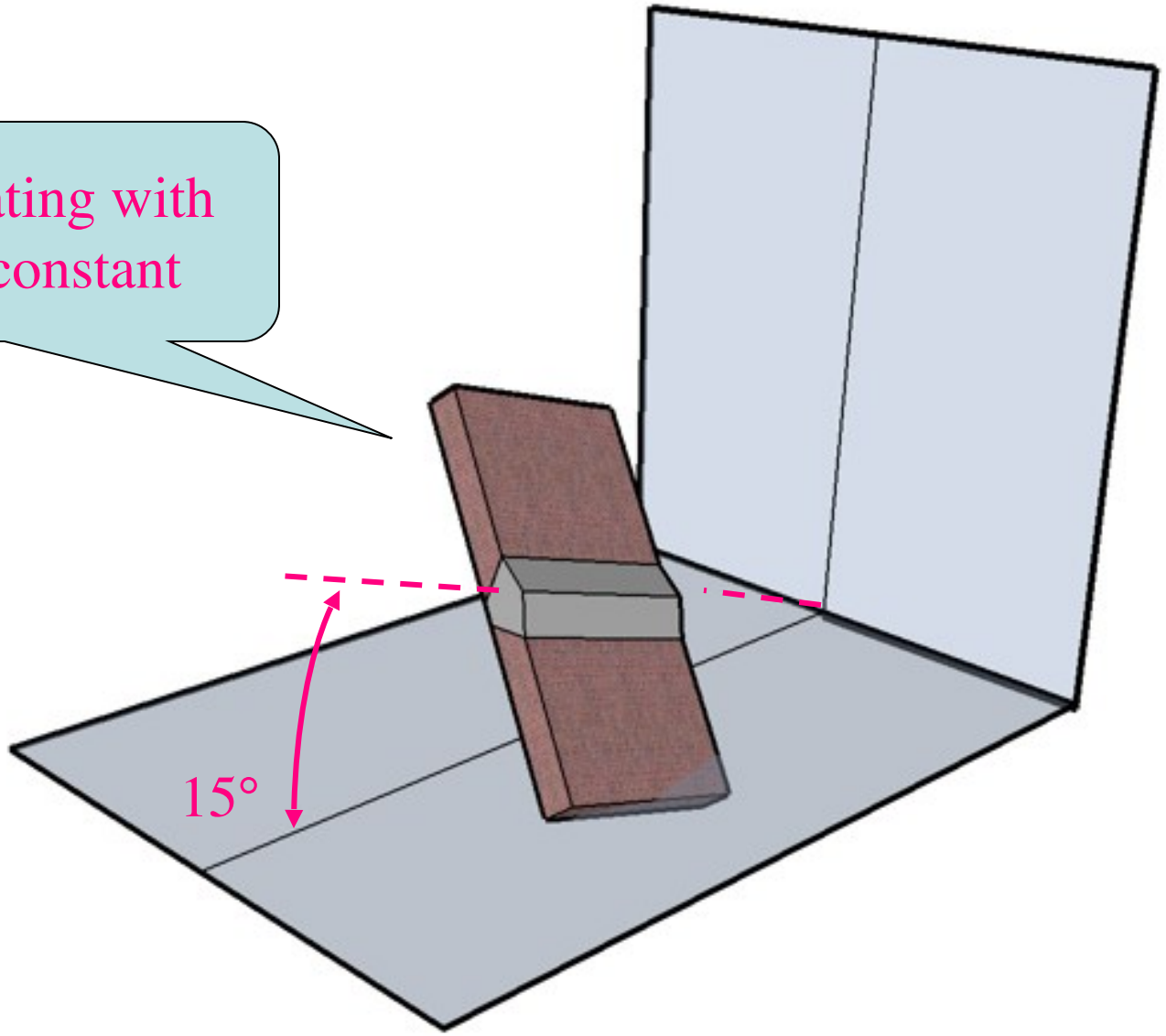


Vertical Position Part 3



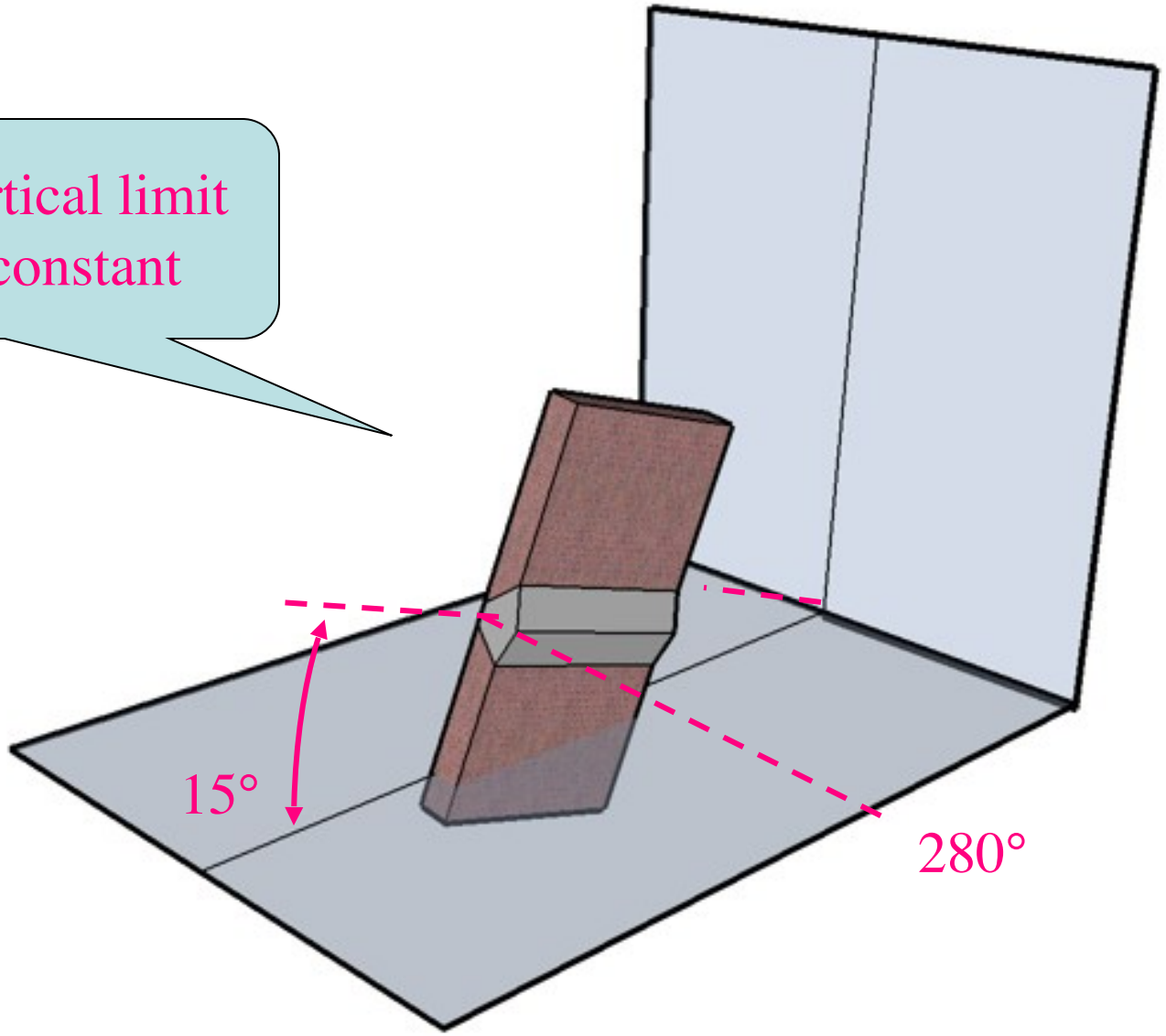
Vertical Position Part 3

Continue rotating with
Inclination constant

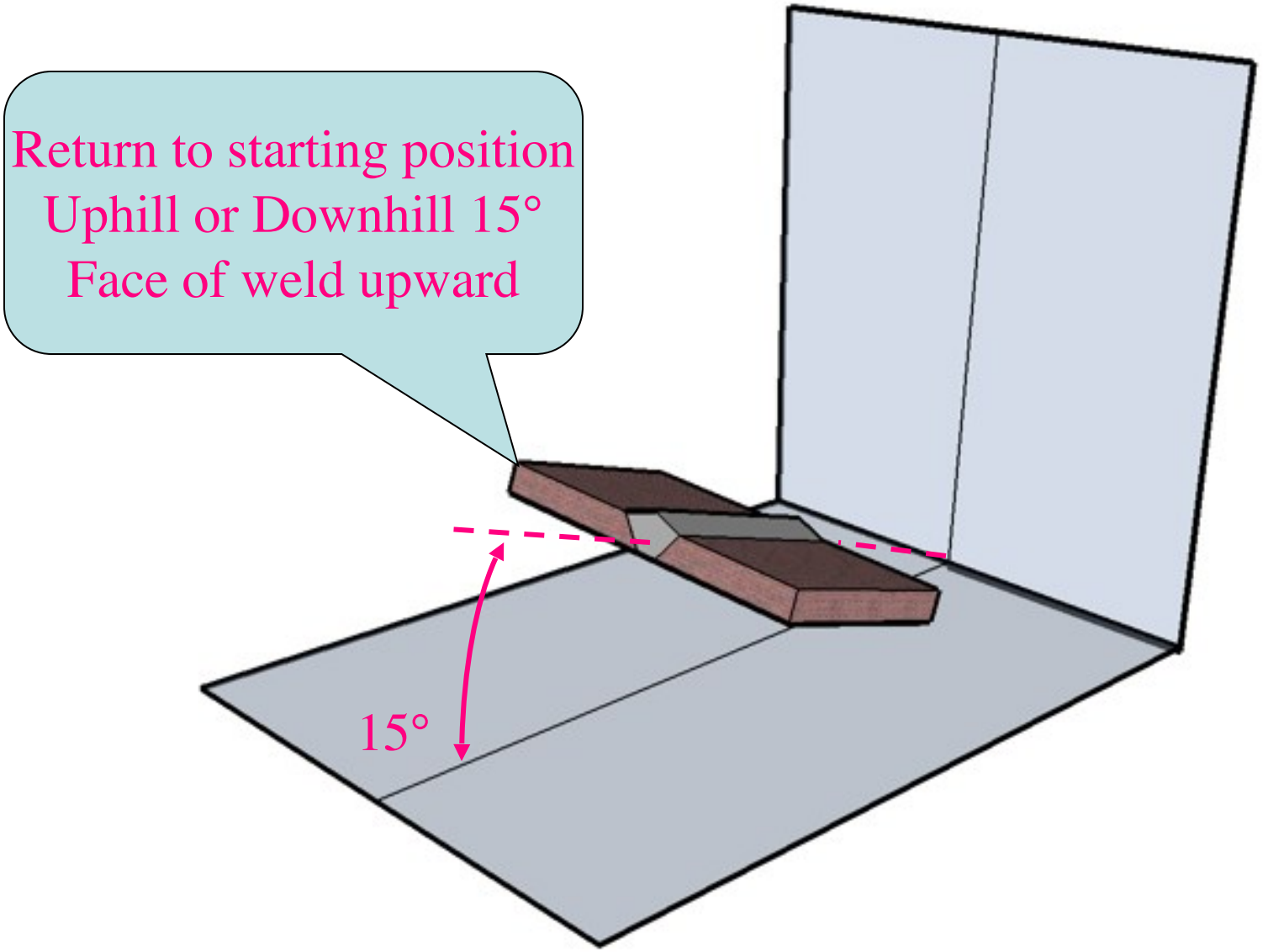


Vertical Position Part 3

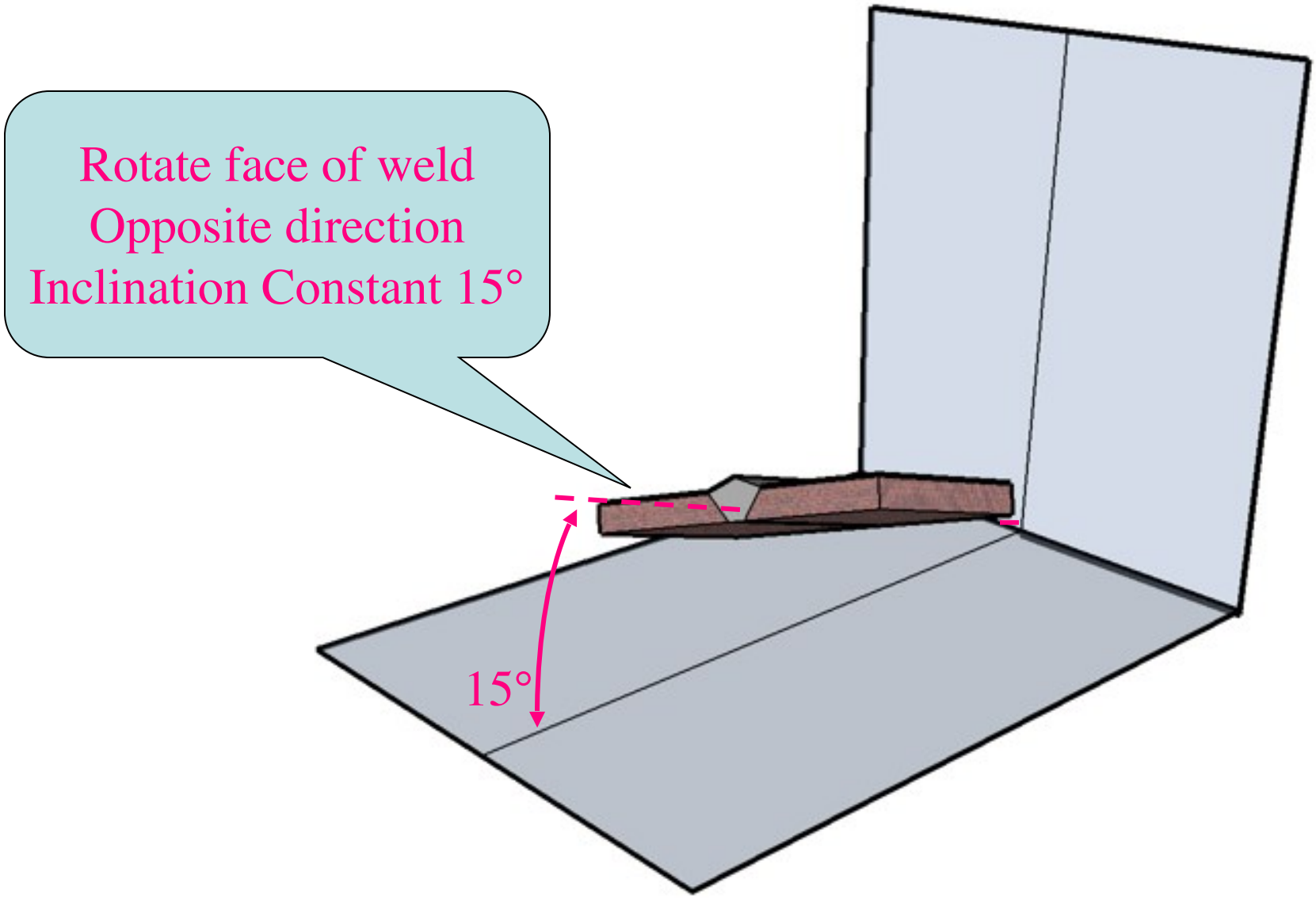
Rotated to vertical limit
Inclination constant



Vertical Position Part 3

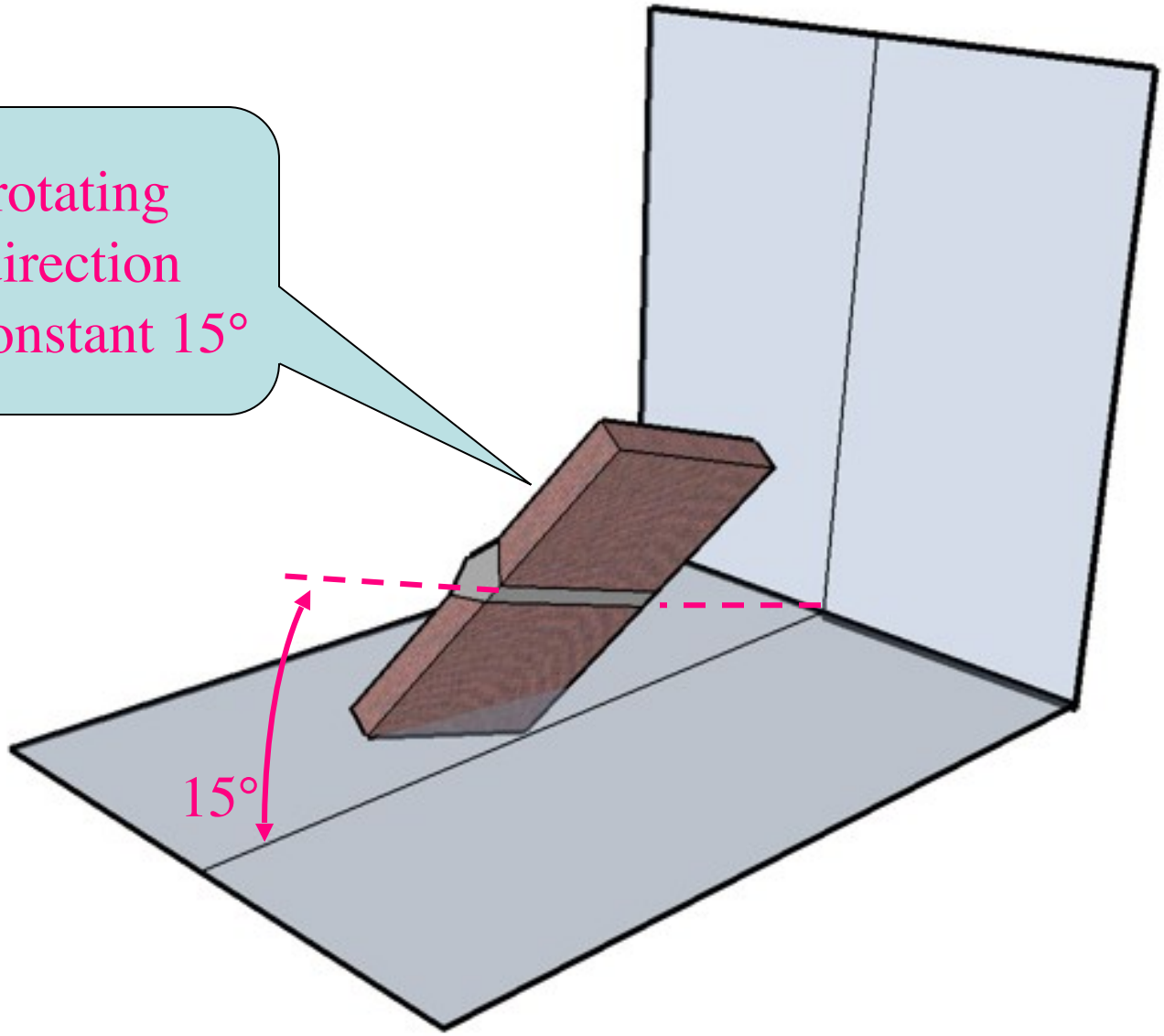


Vertical Position Part 3

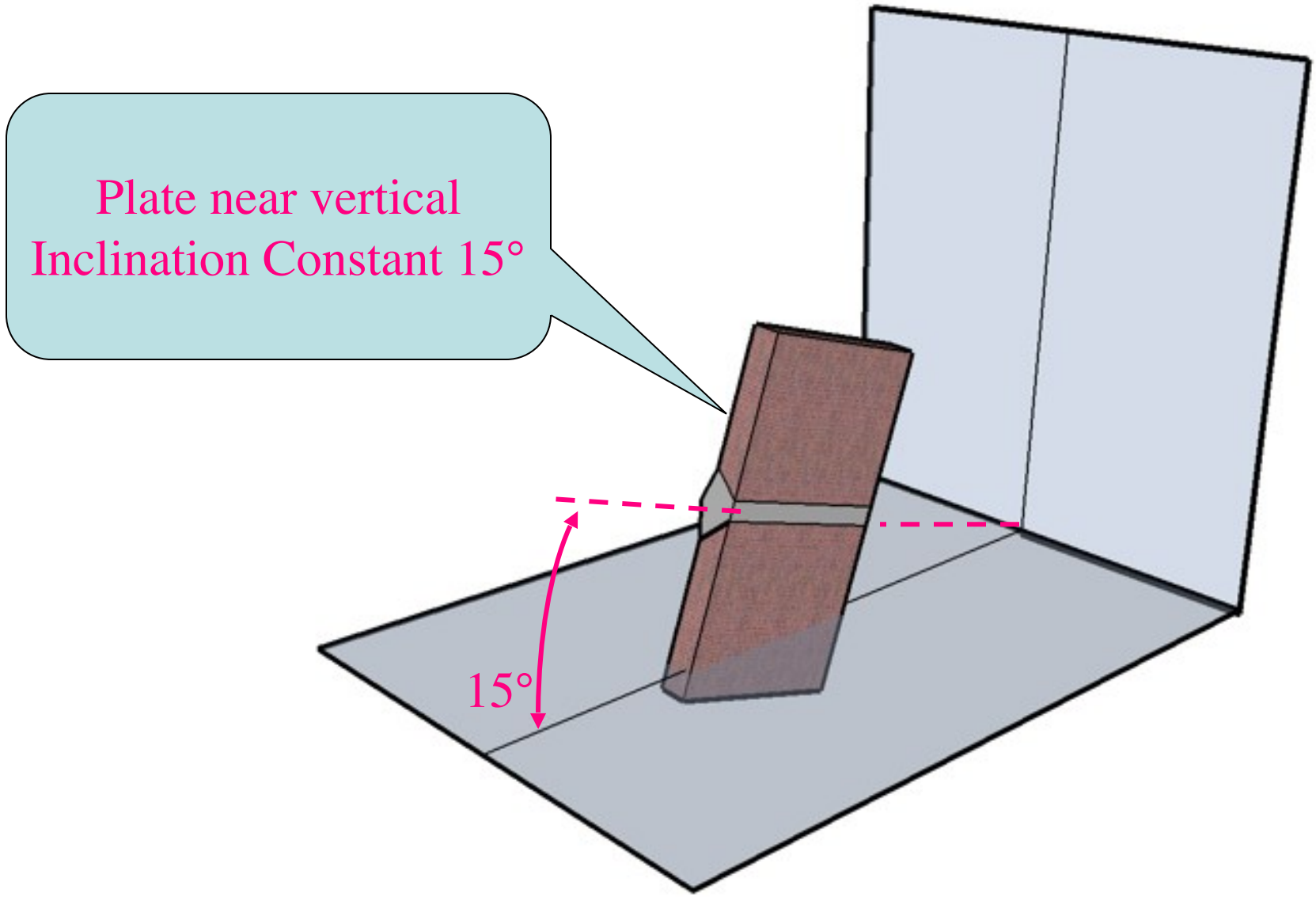


Vertical Position Part 3

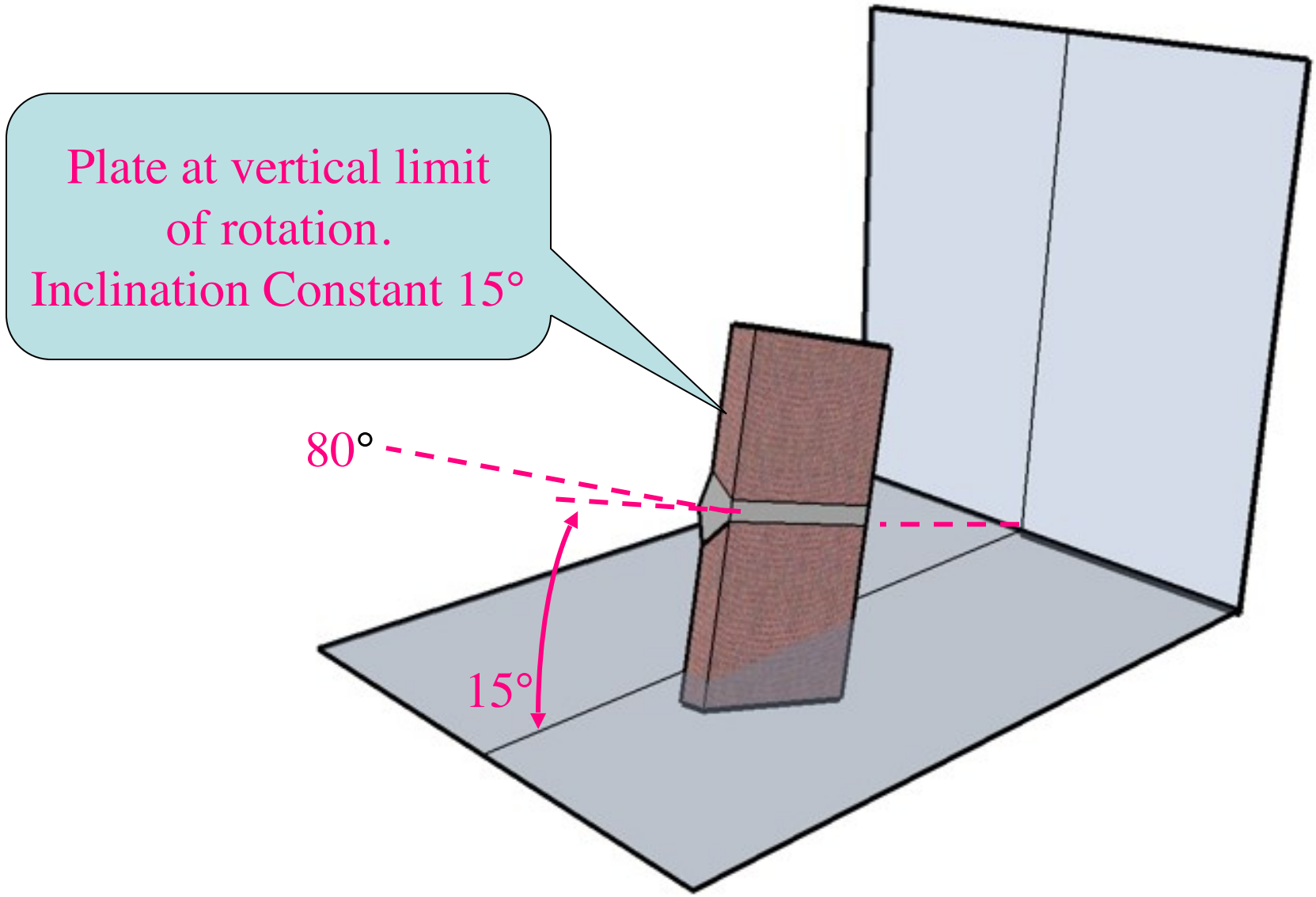
Continue rotating
Opposite direction
Inclination Constant 15°



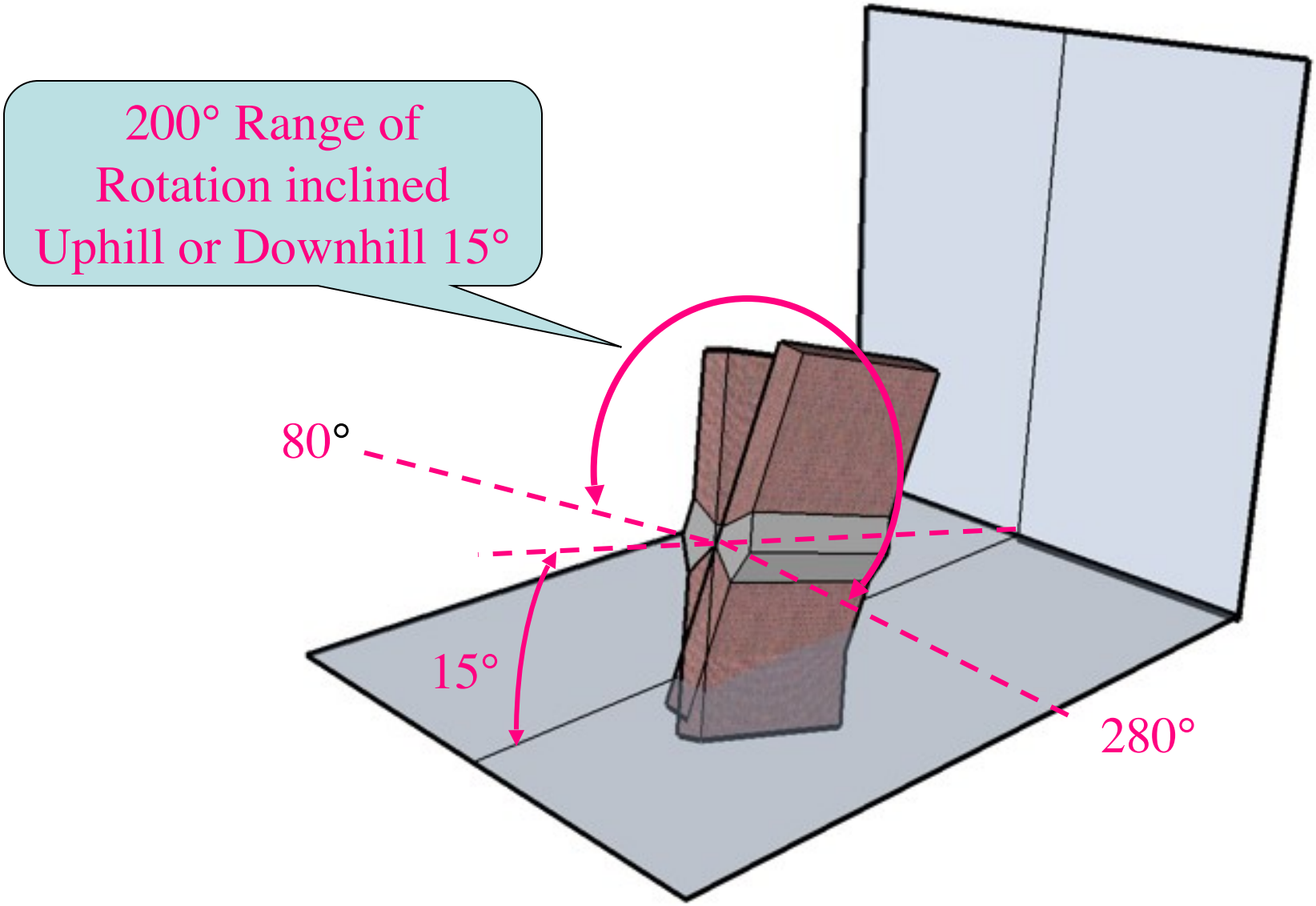
Vertical Position Part 3



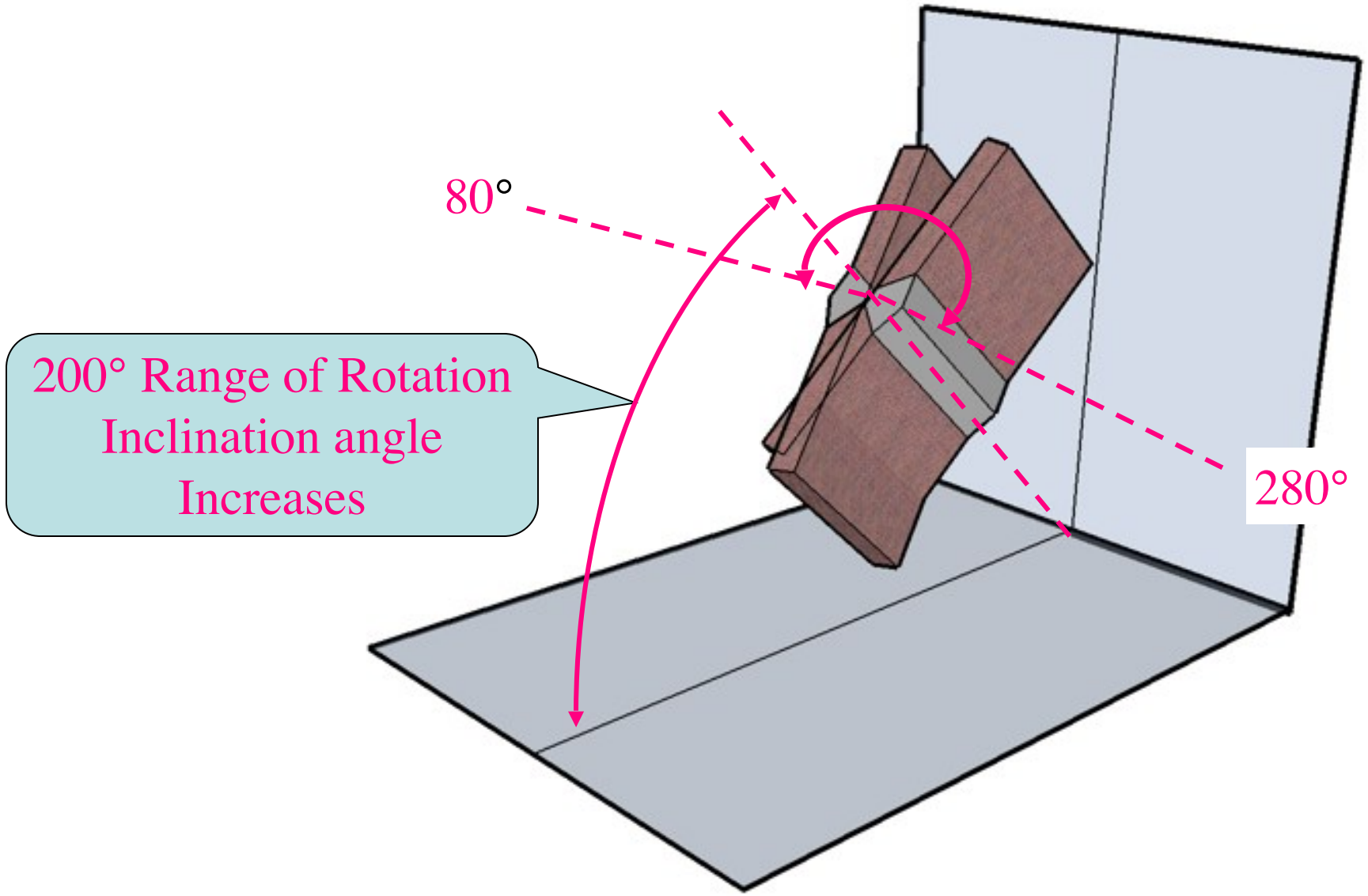
Vertical Position Part 3



Vertical Position Part 3

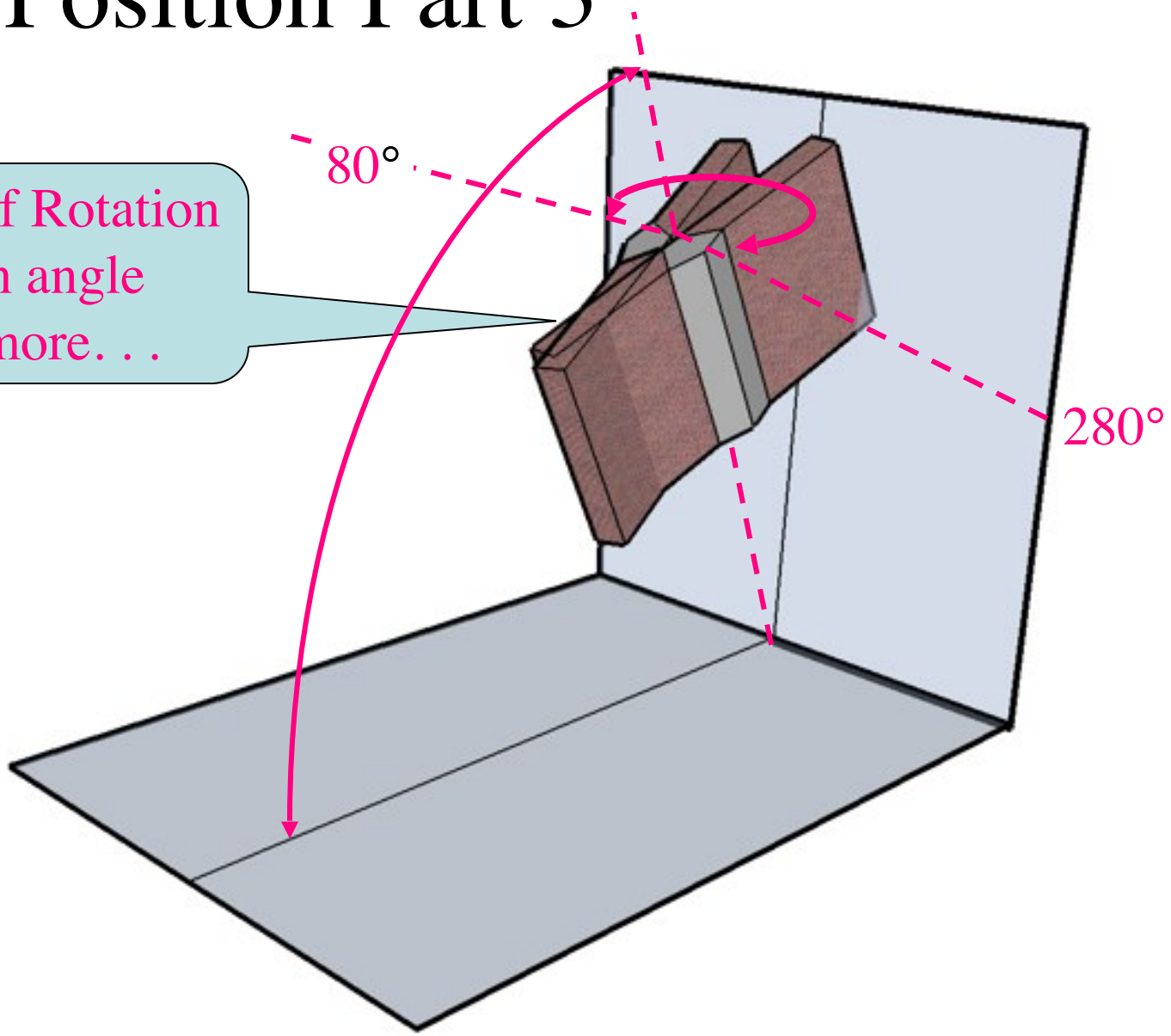


Vertical Position Part 3

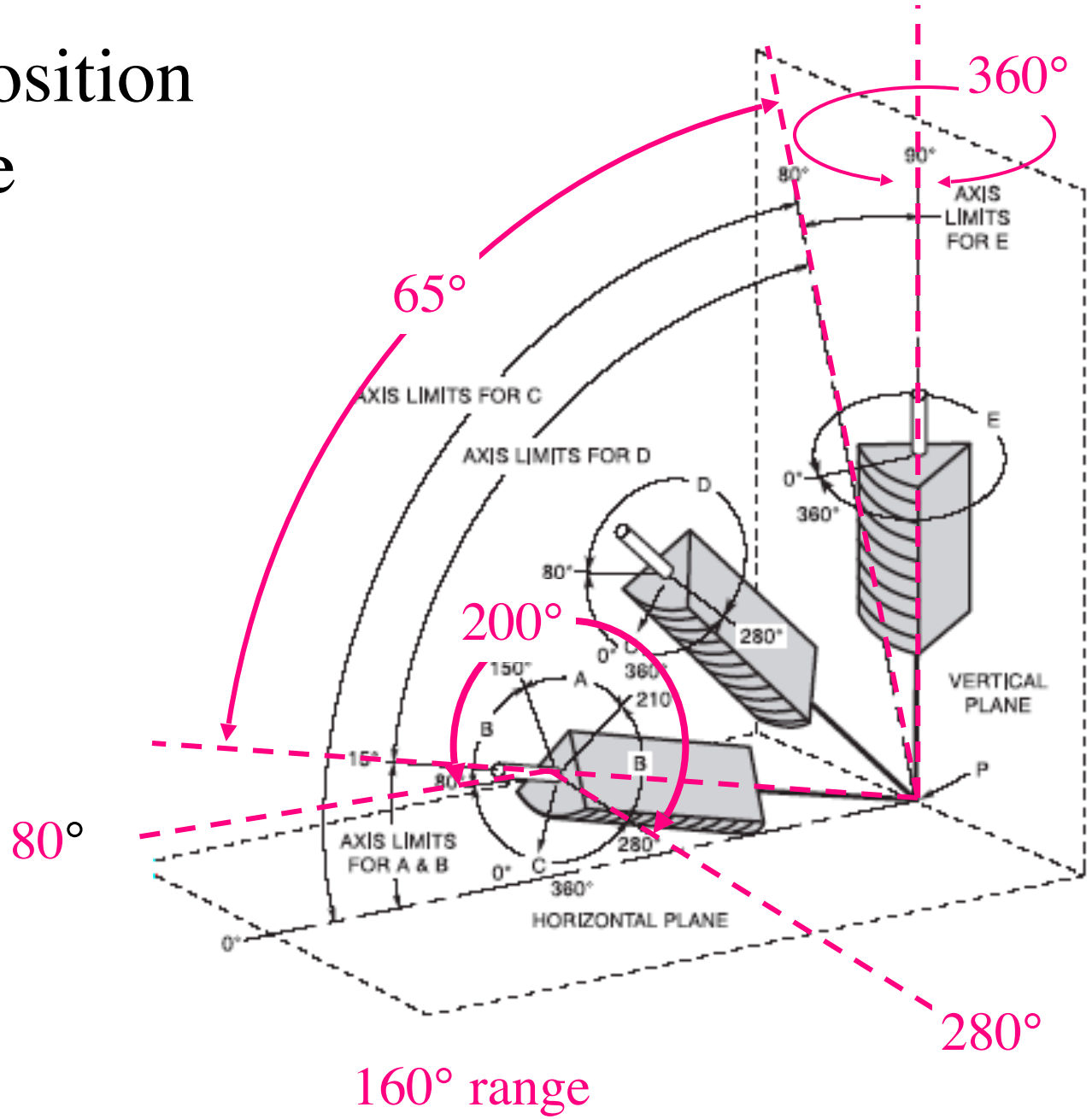


Vertical Position Part 3

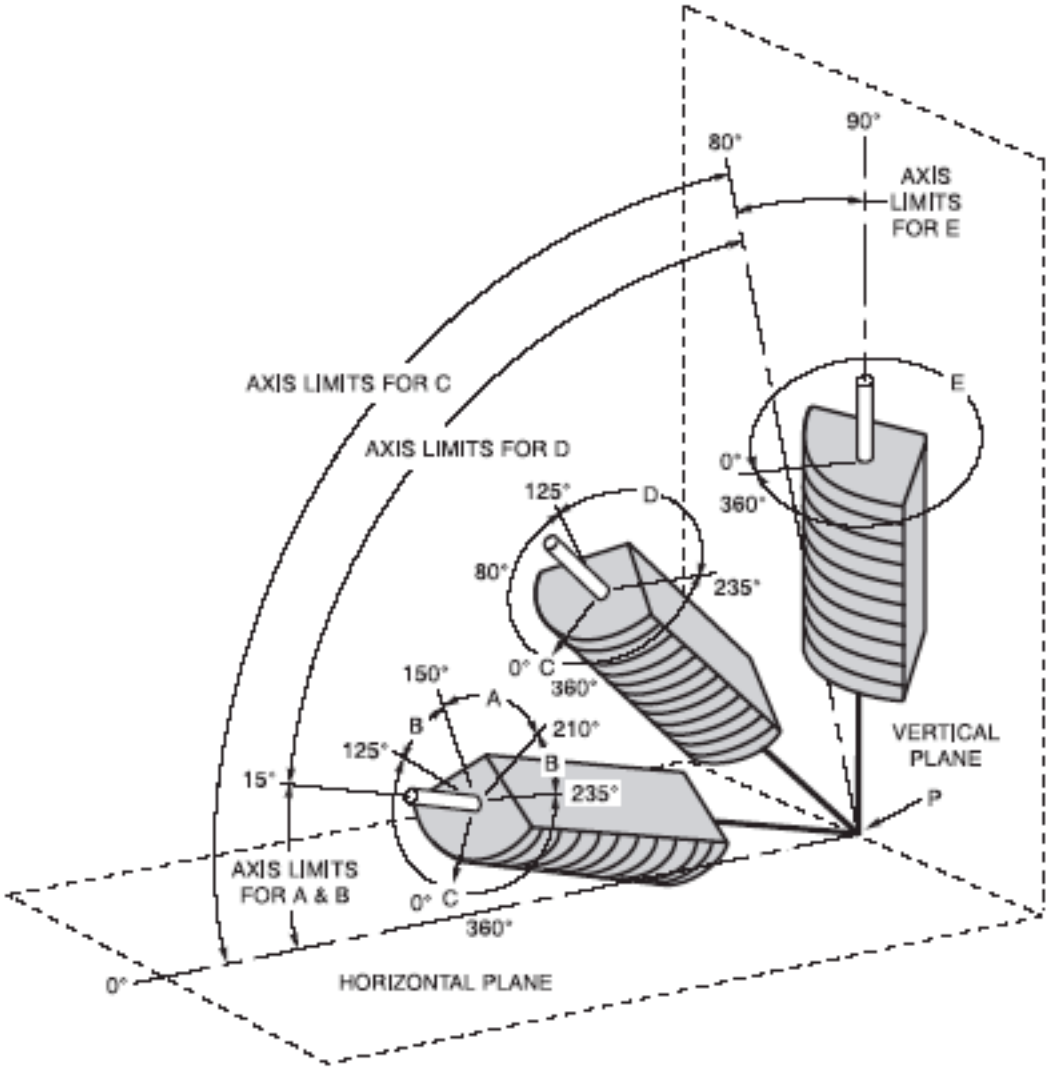
200° Range of Rotation
Inclination angle
Increases more. . .



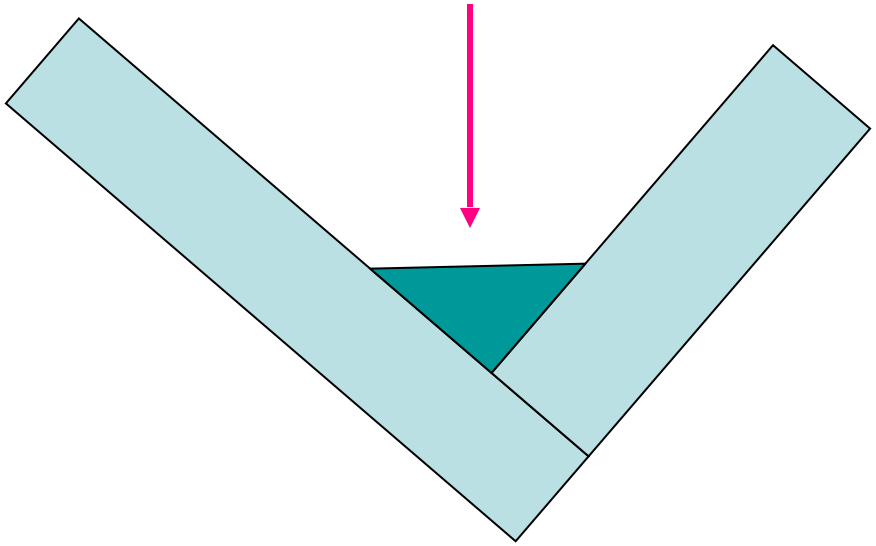
Vertical Position Composite



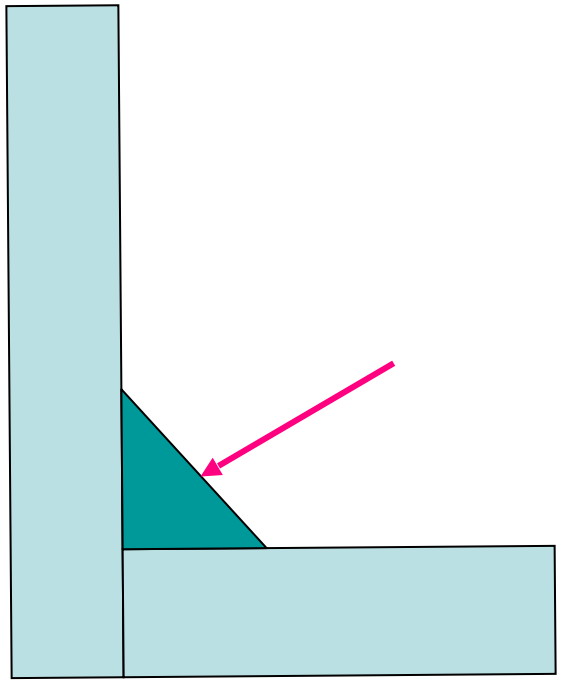
Welding Positions for **Fillet** Welds



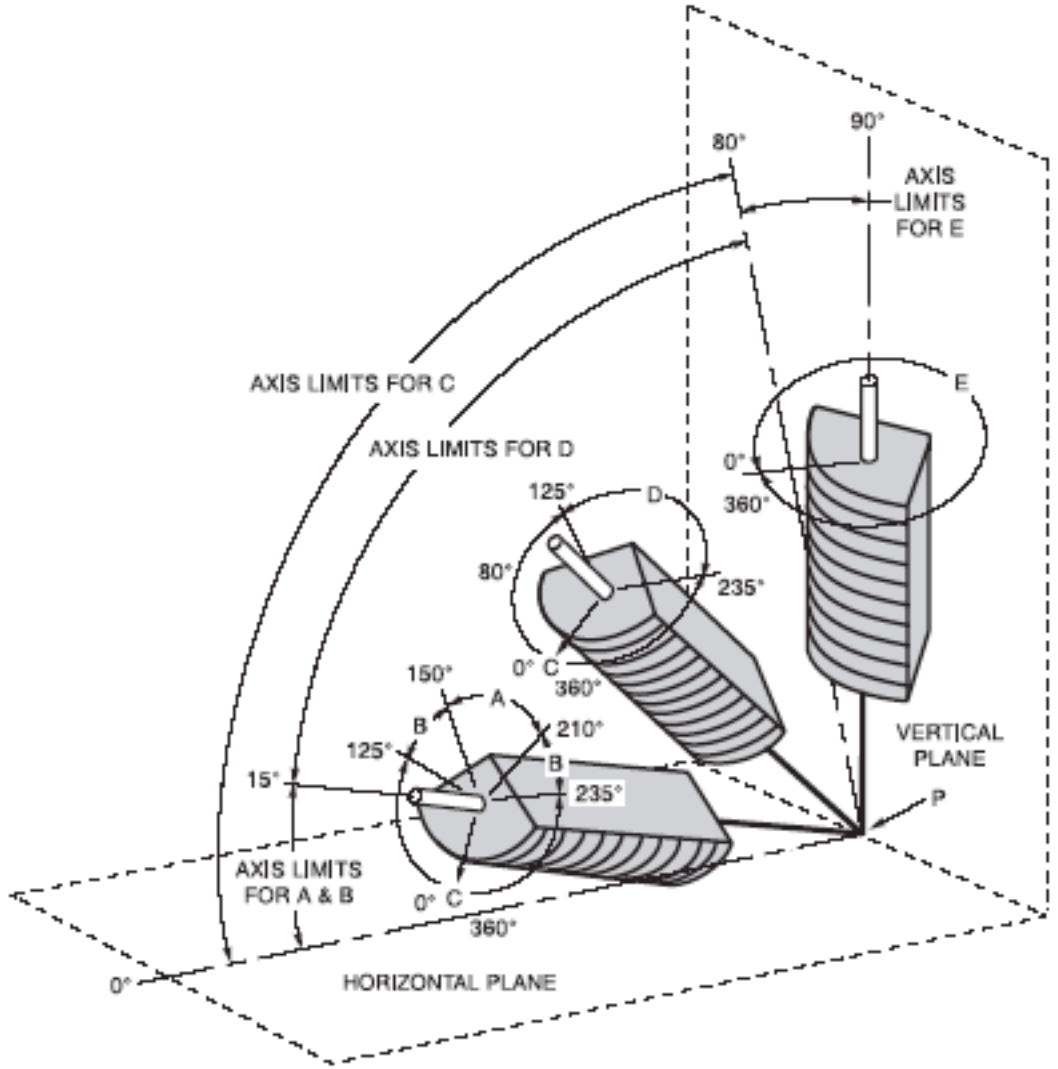
Flat Fillet Weld



Horizontal Fillet Weld



Welding Positions for Fillet Welds



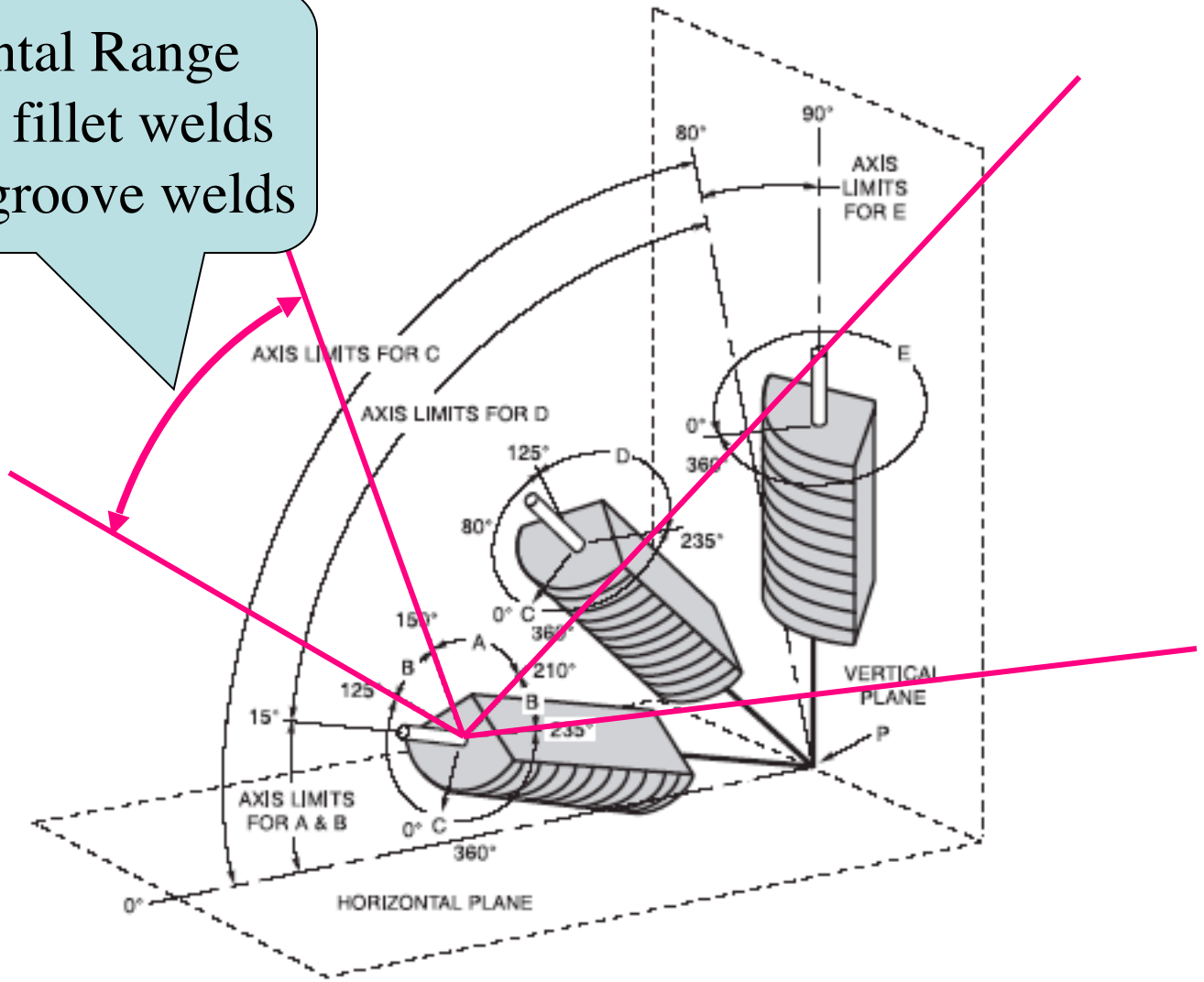
Welding Positions for Fillet Welds

Tabulation of Positions of Fillet Welds

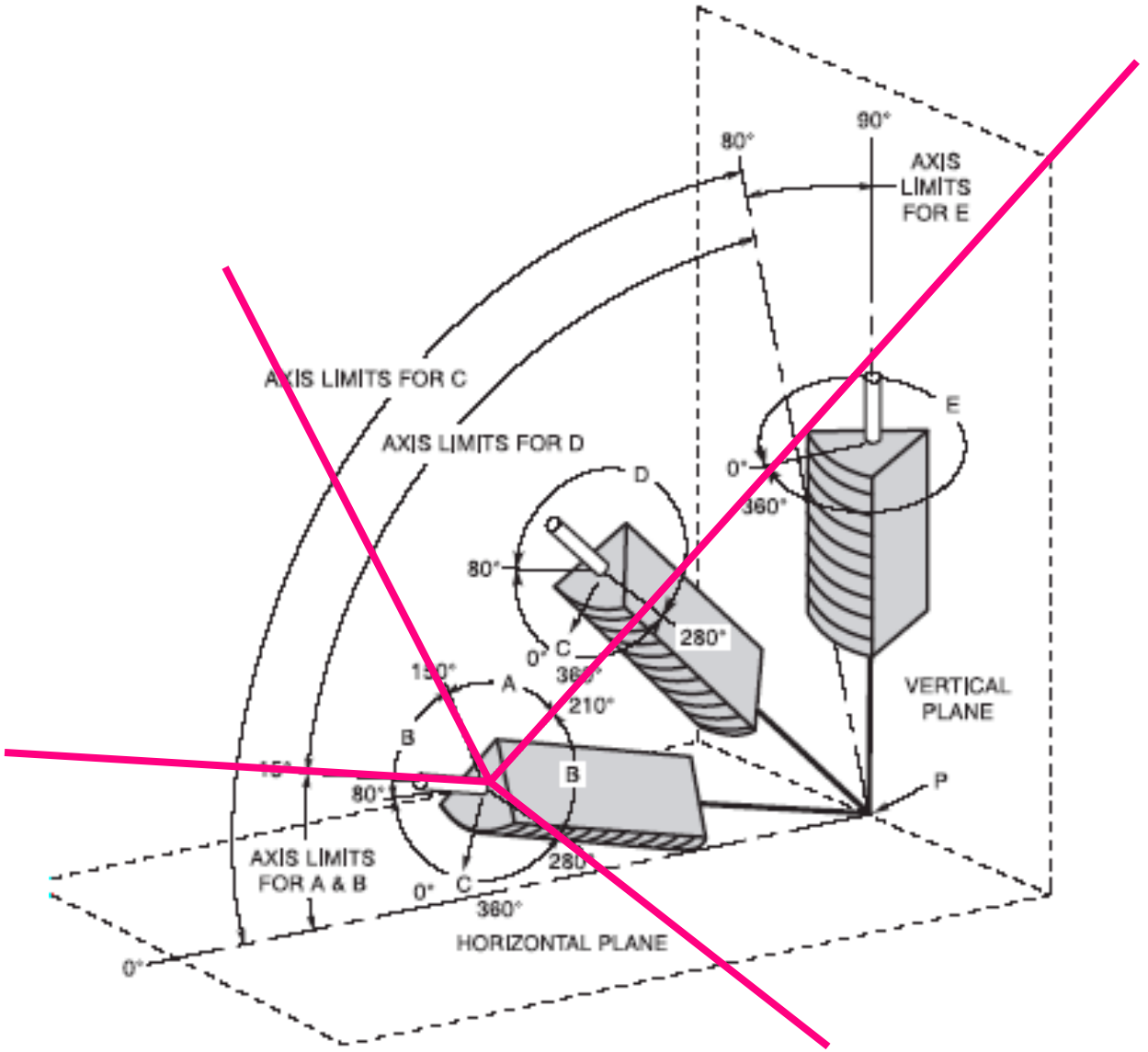
Position	Diagram Reference	Inclination of Axis	Rotation of Face
Flat	A	0 to 15°	150 to 210°
Horizontal	B	0 to 15°	125 t0 150°
			210 to 235°
Overhead	C	0 to 80°	0 to125°
			235 to 360°
Vertical	D	15 to 80°	125 to 235°
	E	80 to 90°	0 to 360°

Welding Positions for Fillet Welds

The Horizontal Range
Is smaller for fillet welds
Than it is for groove welds



Welding Positions for Groove Welds



SCHOOL