Engineering Drawing Lecture- 9

Skew Lines

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THEOREMS :

A theorem is a true statement capable of being proved. The following are a group of theorems which it should be able to be recognize as self-evident truths.

This can only be done by careful study and analysis.

The truths expressed in these theorems will greatly aid in the selection of methods involved in the solution of problems.

LINES and PLANES:

(1) Two lines perpendicular to the same plane are parallel.

(2) Two lines lying on the same plane must either be parallel to each other or will inter sect each other.

(3) Two lines parallel to each other in space will appear parallel, or as points, in all orthographic views.

(4) Two lines appearing parallel to each other in one view are not necessarily parallel to each other in space.

(5) Two perpendicular lines will appear perpendicular in any view that shows a normal view of either or both of the lines. (These lines need not intersect.)

(6) A line external to a plane and parallel to any line on the plane is also parallel to the plane itself.

(7) A line perpendicular to a plane is perpendicular to every line on that plane.

(8) An end view of the line shows the true length of every line on the plane.

(9) If a line is perpendicular to one of two perpendicular planes, it is parallel to the other. If a line is parallel to two intersecting planes, it is parallel to their intersection.

(10) If a line is perpendicular to a plane, then every plane through that line is also per pendicular to that plane.

(11) A point on a plane may have an infinite number of lines passing through it. How ever, only one of these lines can have the same slope as the plane and this line must be perpendicular to a level line on the plane.

(12) No line on a plane can have a slope greater than the slope of the plane.

(13) A plane angle may project smaller or larger than its true size.

(14) A normal view of a plane is an end view of every line perpendicular to that plane.

(15) An edge view of a plane is a normal view of every line perpendicular to that plane.

(16) If two parallel planes are cut by a third plane, the intersections are parallel.

(17) If a plane is perpendicular to two intersecting planes, it is perpendicular to their intersection.

(18) If two planes are perpendicular, a line in one of them perpendicular to their intersection is perpendicular to the other plane.

(19) The angle a line makes with a plane is the angle the line makes with its projection on that plane.

(20) If two planes are parallel, any line in one plane is also parallel to the other plane.

SKEW LINES :

Skew lines are lines which are non-intersecting and non-parallel.

One of the most common engineering problems is that of determining the true length, slope, and bearing of the shortest line connecting two skew lines.

Problems which involve clearances between cables, pipes, braces, etc. are typical of those encountered in the engineering profession.

Another application of these principles which require the shortest connecting tunnel between two mine tunnels.

Still another practical application of the principles

involves finding the shortest connection between two oblique sewer lines or pipelines (see Fig.)

In this case the shortest possible sewer or pipe connection will probably involve the use of right-angled tees since the shortest distance between any two skew lines is a third line H F which is perpendicular to both.

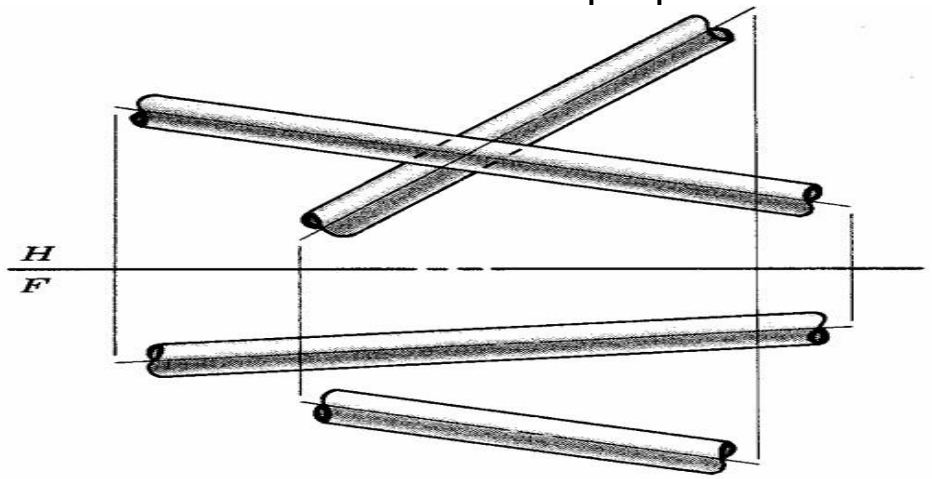

Fig. 3-1. Non-intersecting, Non-parallel Pipelines

To DRAW a PLANE CONTAINING ONE GIVEN LINE and PARALLEL to ANOTHER GIVEN LINE

Example:

In Fig. below we have given the plan and front elevation views of two non-intersecting, non-parallel lines AB and CD.

Through any point on the line CD, in this case Z, the line XY is drawn parallel to the line AB in space. This procedure is followed in both views, thus determining a plane CDXY, one line of which, XY, is parallel to the line AB in space. This solution can be verified by drawing another view showing the plane as an edge. In this view the line AB will appear parallel to the plane.

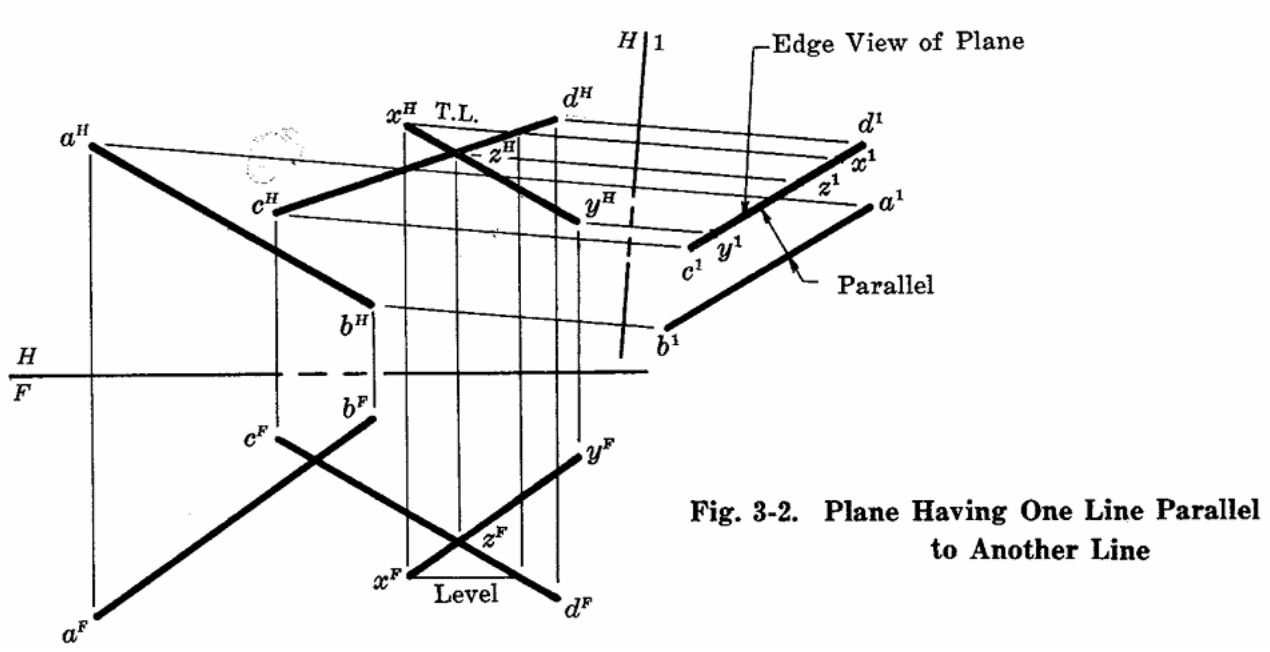

Fig. 3-2. Plane Having One Line Parallel to Another Line

To DETERMINE the SHORTEST DISTANCE BETWEEN any TWO NON-INTERSECTING, NON-PARALLEL LINES :

Analysis: (Line Method)

The shortest distance between two non-intersecting, non-parallel lines will be the perpendicular distance.

Example:

The two non-intersecting, non-parallel lines AB and CD are given in both the plan and front elevation views in Fig. 3-3 below.

Since either of the lines can be shown in its true length,

1- draw an auxiliary elevation view in which the true length of the line AB will appear.

Also show line CD in this view.

2- The shortest distance will be perpendicular to line AB but its exact location is yet unknown.

3- Draw an inclined view showing the line AB as a point.

The shortest distance will be the perpendicular distance from AB to the line CD even though the true length of CD does not appear in this view.

Label the shortest distance line XY and project this common perpendicular back to view 1.

Since XY is in its true length in view 2, it must be parallel to the folding line 1-2 in view 1.

Also XY must be perpendicular to AB in view 1, where AB is shown in true length.

Therefore point X can be located in view 1. Project XY to the H and F views.

The bearing of the shortest distance line can be measured on the plan view. To determine the slope of the shortest distance line, a new auxiliary elevation view is drawn showing only the line XY in its true length. This true length distance will of course check with line XY in the inclined view 2.

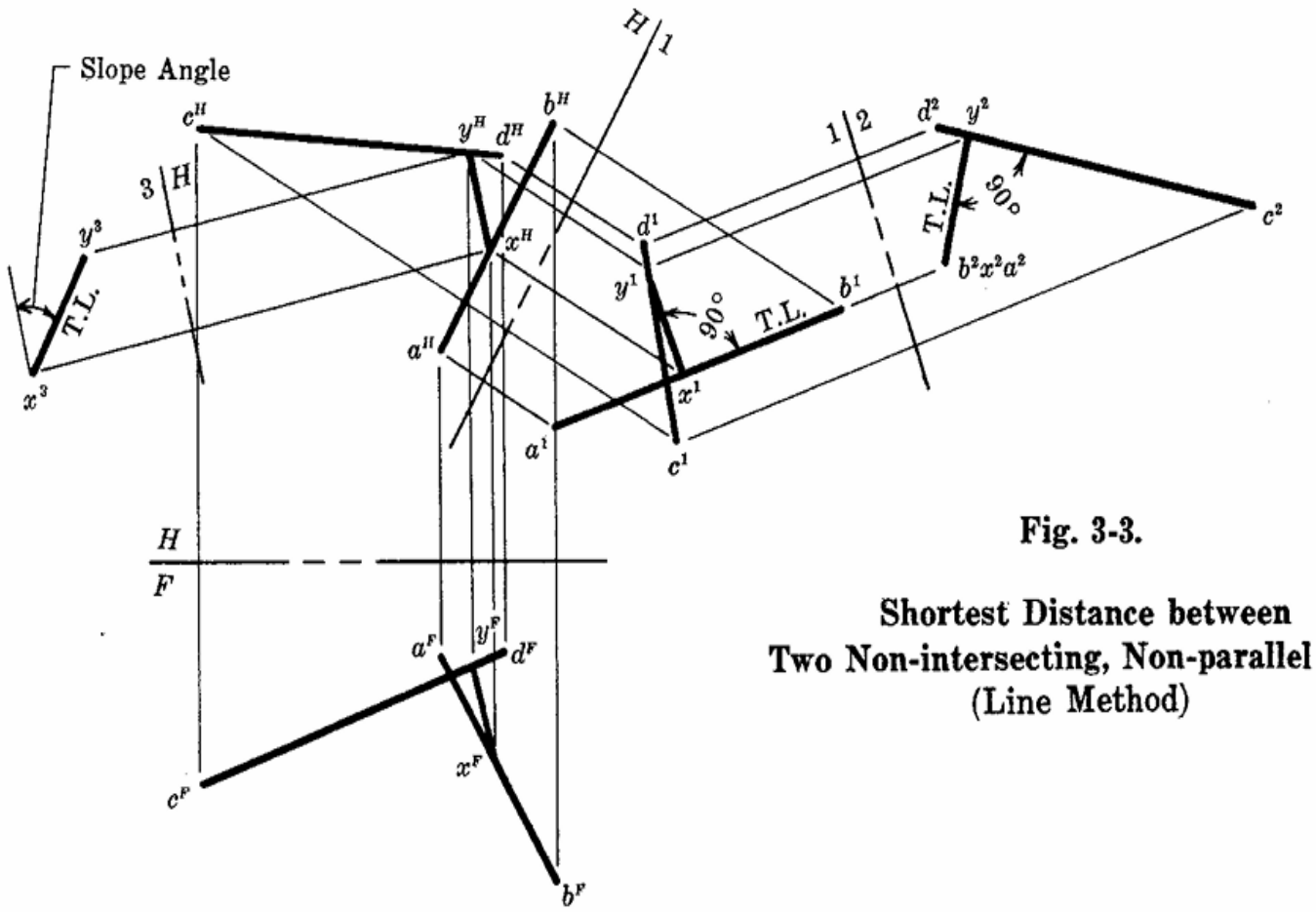

Fig. 3-3.

Shortest Distance between Two Non-intersecting, Non-parallel Lines (Line Method)

(**Plane Method) :**

Analysis:

Through one of the given lines pass a plane having a line parallel to the other given line.

An elevation view showing the plane as an edge will not only show the true length of the perpendicular distance but will also show its slope.

To determine the exact location of this shortest distance, a new view must be projected having lines of sight perpendicular to the edge view of the plane. This view will show both the given lines in their true length and the perpendicular distance between these two lines will show as a point in this inclined view where the lines appear to intersect.

Example:

The plan and front elevation views of lines AB and CD are given in Fig. 3-4 below.

A plane CDE is constructed containing line CD and having DE parallel to line AB.

. Draw an auxiliary elevation view showing the plane as an edge.

the line AB will be parallel to the edge view of the plane in this view.

The perpendicular distance between the plane and the line

will be the true length of the shortest distance.

To determine the exact lo cation of this shortest distance,
project an inclined view directly off the auxiliary elevation view
to see the true length of both lines AB and CD.
Since folding line 1-2 was placed parallel to the edge view of the plane,
the inclined view will also show the true size of the plane.
The point view of the shortest distance XY
will be located where the true length of both lines appear to intersect.
Project line XY back to the auxiliary elevation view
and then CE on to the other views.
Note that the plan view of line XY will be parallel to the H-1 folding line,
since the true length of XY is shown in view 1.
The slope of the shortest distance line will appear in view 1,
whereas the bearing will be determined by its position in the plan view.

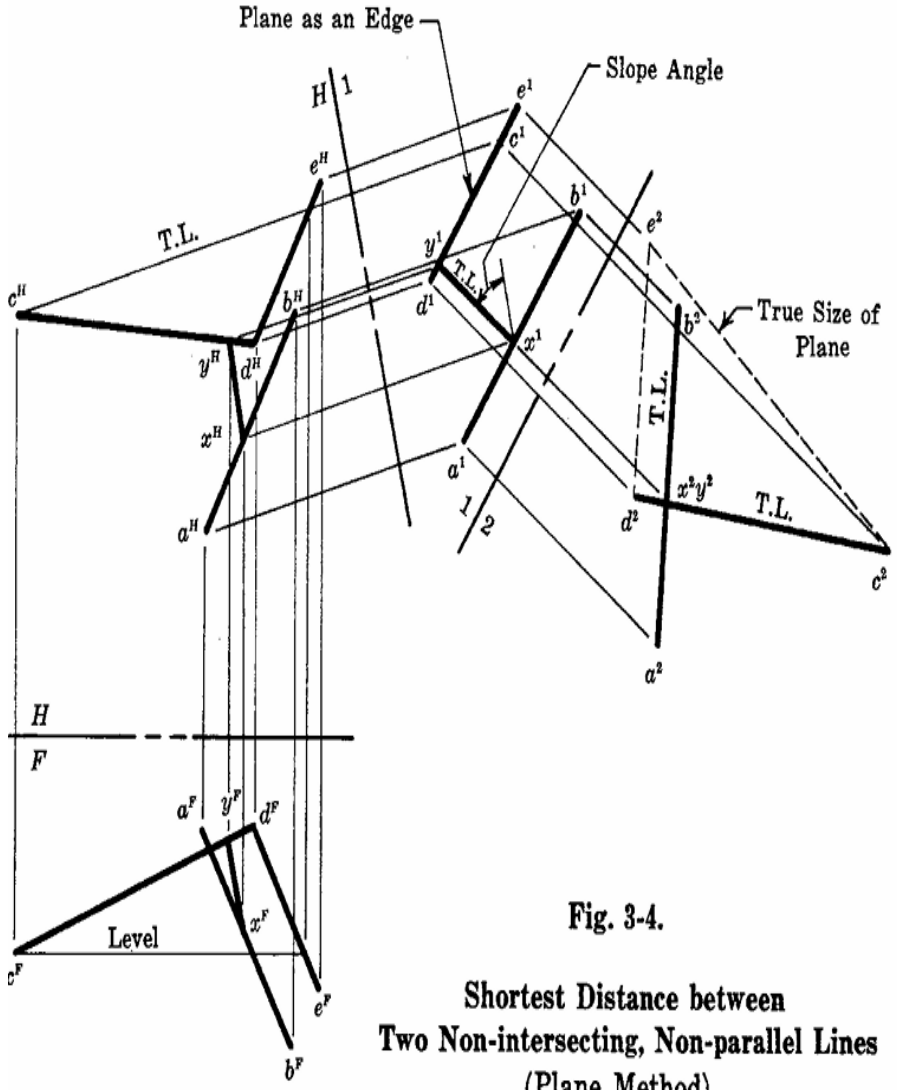

Fig. 3-4.

Shortest Distance between
Two Non-intersecting, Non-parallel Lines
(Plane Method)

To DETERMINE the SHORTEST LEVEL DISTANCE BETWEEN TWO NON-INTERSECTING, NON-PARALLEL LINES:

In many phases of engineering the problem arises relative to locating the shortest level distance between two skew lines representing the center lines of pipes, tunnels, wires, braces, etc.

As an example, in mining engineering it is often deemed imperative to connect two tunnels with a new passage way having no slope at all. Quite often a track is to be laid between two tunnels and the track is to be perfectly level.

Analysis:

The shortest level distance between two skew lines will appear in its true length when the plane which contains one skew line and is parallel to the other appears as an edge.

Example:

In Fig. 3-5 below, the two skew lines AB and CD are given in both the plan and front elevation views.

The plane CDE is drawn containing the line DE parallel to line AB.

The auxiliary elevation view is drawn showing the plane as an edge and the line AB parallel to it.

The shortest level distance is the level distance between the two parallel lines, one of which represents the edge view of a plane.

This level distance will be parallel to the B-1 folding line.

To show the point view of the shortest level distance, folding line 1-2 must be located perpendicular to the B-1 folding line.

The elevation view 2 will determine the exact location of the level line as the point where the lines AB and CD appear to intersect.

The level line XY is then projected back to the other views, and it will be noted that line XY in the plan view will appear in its true length.

In the front elevation view, the line XY must be parallel to the H-F folding line, since every level line is parallel to the horizontal image plane.

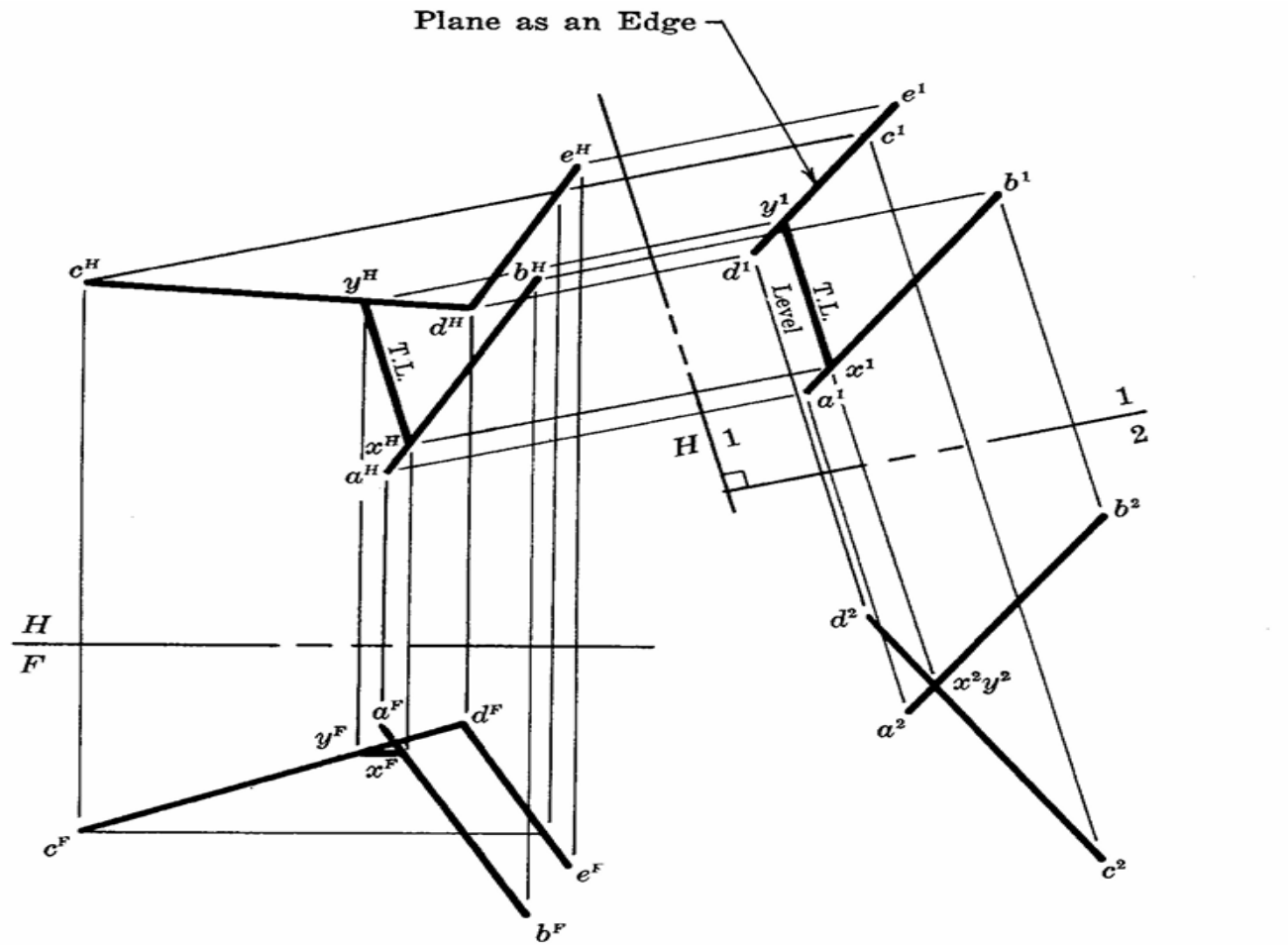

Fig. 3-5. Shortest Level Distance between Two Non-intersecting, Non-parallel Lines