

KES

Design Standard for Hypoid Gear

KES M – L002

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1. Scope of Application

This standard shall be applicable for the design method of a hypoid gear used as an axle shaft deceleration device for a car.

2. Purpose

The purpose of this standard is to standardize the design method of a hypoid gear, make the design performance appropriate and achieve the business efficiency.

3. Meaning of Terminology

3.1 Gear and Pinion

(1) Gear

It is a driven gear between a pair of gears and has more teeth than the other.

(2) Pinion

It is a driving gear between a pair of gears and has fewer teeth than the other.

3.2 Part name of tooth

(1) Toe

Inner-side end part of a tooth surface

(2) Heel

Outer-side end part of a tooth surface

(3) Top

Upper part of a tooth surface

(4) Flank

Lower part of a tooth surface

(5) Top land

Upper surface of a tooth

(6) Bottom land

Lower part of a tooth

(7) Drive side

It is a contact surface at forward condition and called a convex side with the gear of rh hand spiral as a standard.

(8) Coast side

It is a contact surface at deceleration or reverse condition and called a convex side with the gear of rh hand spiral as a standard.

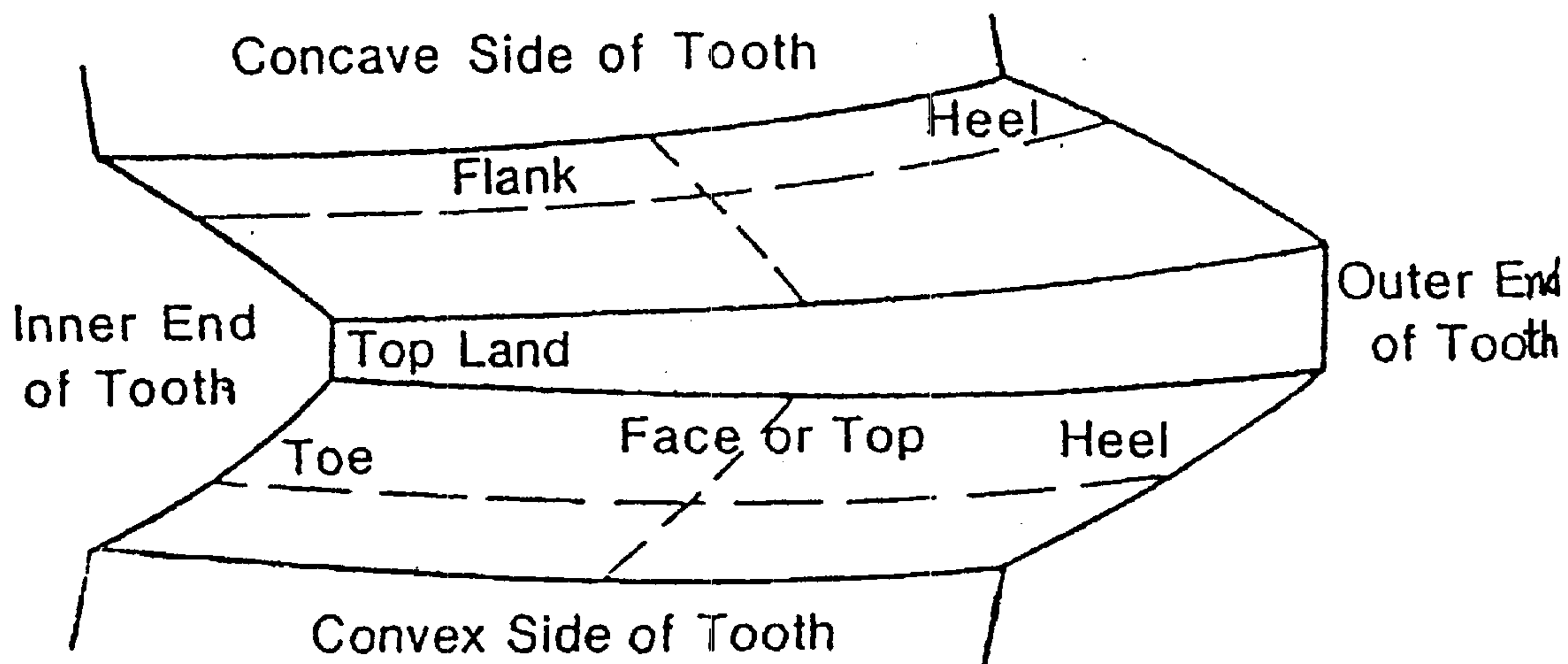


Fig 1. Gear tooth nomenclature

3.3 Spiral bevel gear

Two axes are perpendicular mutually. Tooth curves and leans to an axis. It has the point contact and efficiency of 95%.

3.4 Hypoid gear

Two axes are perpendicular mutually, but it differs from a spiral bevel gear at the point that an axis of a pinion has the offset in upward or downward to an axis of a gear.

Because the intensity of a pinion is improved largely and it slides in longitudinal direction, the grinding is much easier than that of a spiral bevel gear, and a smooth and

silent rotation is possible. Its efficiency is 90%.

3.5 Outer cone distance : A_o

Distance to the end of a tooth surface along the pitch line

$$A_o = \frac{D}{2 \sin \Gamma}$$

Where, Γ : pitch angle

3.6 Face width : F

It is the distance in the section of a tooth axis along the pitch line, and determined as $1/3 \sim 1/4$ of the outer cone distance.

3.7 Mean cone distance : A

(1) Distance to the center point of a tooth surface along the pitch line

$$(2) A = A_o - \frac{F}{2}$$

(3) It is a reference point for the calculation of the stress, and a nominal spiral angle is measured at this point.

3.8 Circular pitch

Distance from a point of outer cone to a same point of next tooth along the pitch line

3.9 Working depth : h_K

It is the practical depth of a tooth when a pair of gears is engaged.

3.10 Whole depth : h_t

Working depth + Clearance

3.11 Pitch diameter : d, D

$$(1) d = \frac{n}{P_d} \quad \text{Or } D = \frac{N}{P_d}$$

(2) It is needed to use a long & short addendum format for the tooth proportion.

(3) In general, under-cut in a pinion is decreased with shorter addendum and longer dedendum in a gear than a pinion.

3.12 Outside diameter : d_o , D_o

$$(1) d_o = d + 2 a_{op} \sin r$$

$$(2) D_o = D + 2 a_{og} \sin \Gamma$$

(3) a_{op} , a_{og} : Addendum of each pinion and gear

(4) r , Γ : Pitch angle of each pinion and gear

3.13 Pitch angle : r , Γ

$$(1) \tan^{-1} r = \frac{n}{N} \quad (\text{In case of shaft angle} = 90^\circ)$$

(2) Angle between the base line of a pitch and axis of a gear

3.14 Face angle : r_o

$$(1) r_o = r + \delta_g \text{ or } \Gamma_o = \Gamma + \delta_g$$

(2) δ_p , δ_g : Dedendum angle of each pinion and gear

(3) Angle between the base line of a end cone and axis of a gear

3.15 Root angle : r_R , Γ_R

$$(1) r_R = r - \delta_p \text{ or } \Gamma_R = \Gamma - \delta_g$$

(2) Angle between the base line of a root cone and axis of a gear

3.16 Dedendum angle : δ_p , δ_g

Because the dedendum angle is proportional to a dedendum, $\delta_o = \frac{b_o}{A_o}$.

But it is not proportional to a dedendum for the design of special tilted road line. In this case, after the determination of the cutter diameter and spiral angle, calculate the dedendum angle with an appropriate slot width taper.

3.17 Tooth taper

Tooth taper prescribe the slot width format and cutting method that have to be considered for the calculation of a blank dimension.

(1) STD

The apex of a standard tooth taper and root cone coincide with that of a pitch cone.

$$\tan \delta = \frac{b_o}{A_o} = \frac{b}{A} = \frac{b_i}{A_i}$$

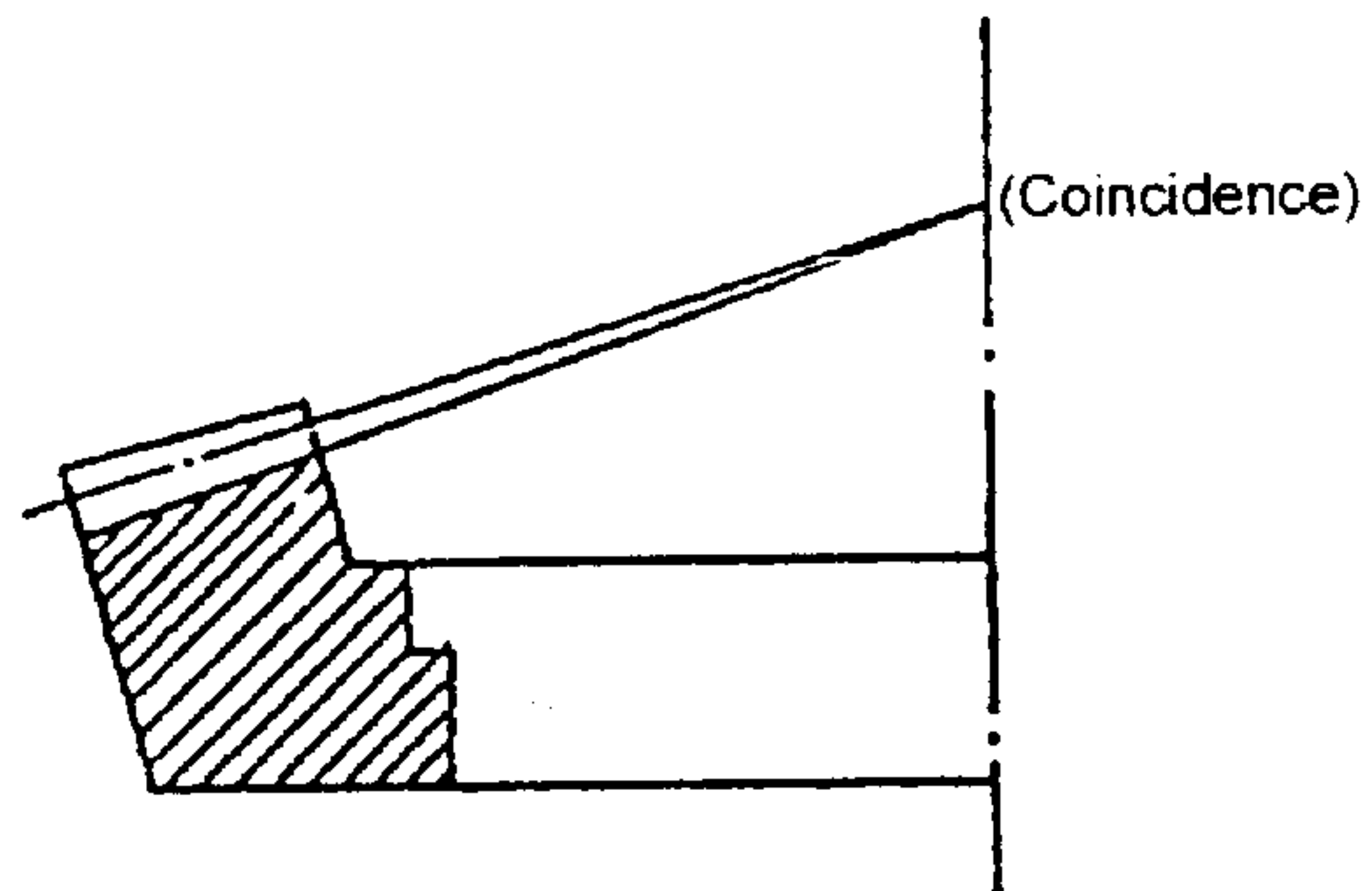


Fig 2. Standard tooth taper

(2) Trill

It is an inclined taper to a large end for a root line to make an approximate duplex taper.

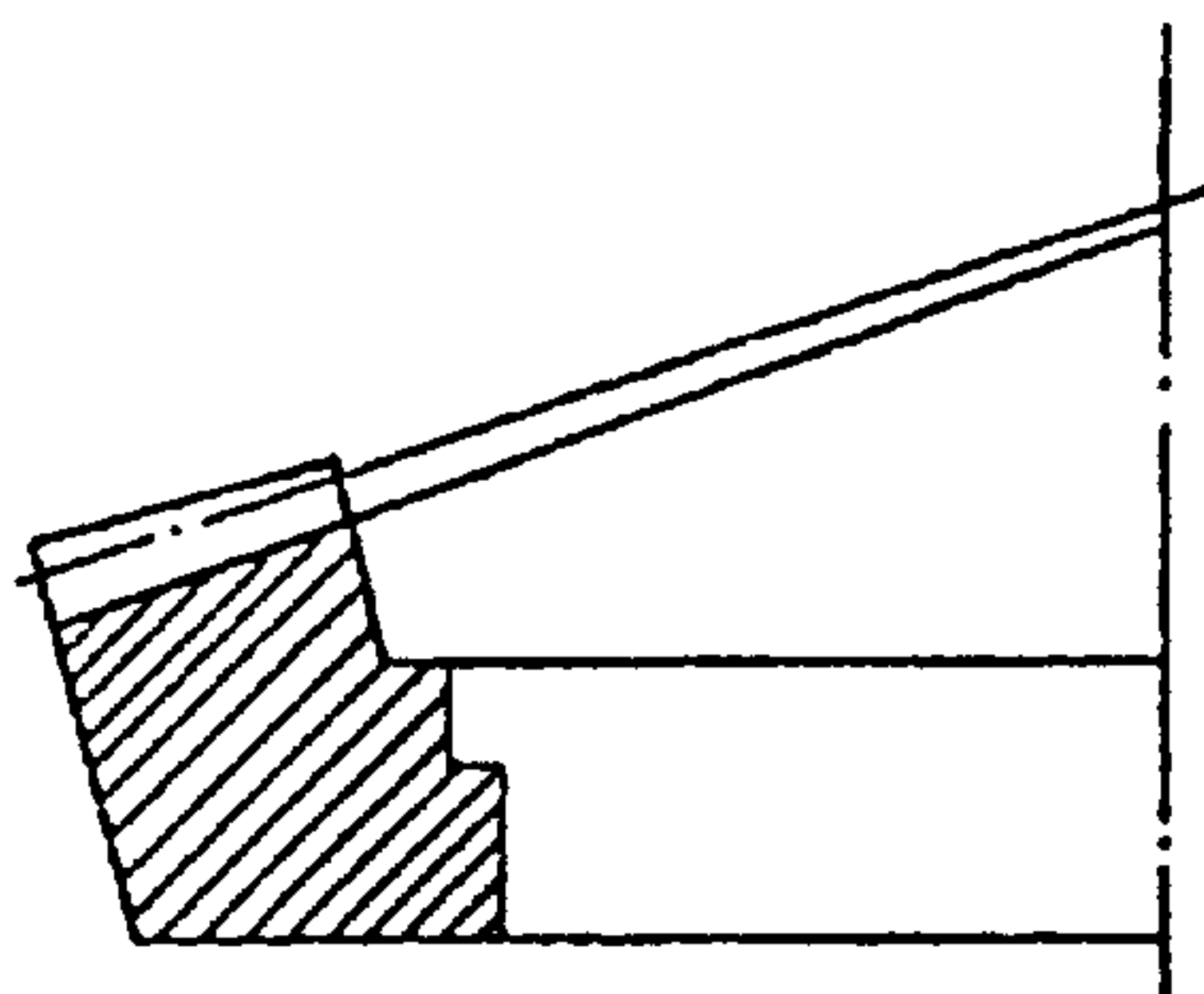


Fig 3. Trill

(3) Trim

It is an inclined taper to a mean point for a root line to make an approximate duplex taper. This method is generally used for the cutte with a smaller diameter than normal one.

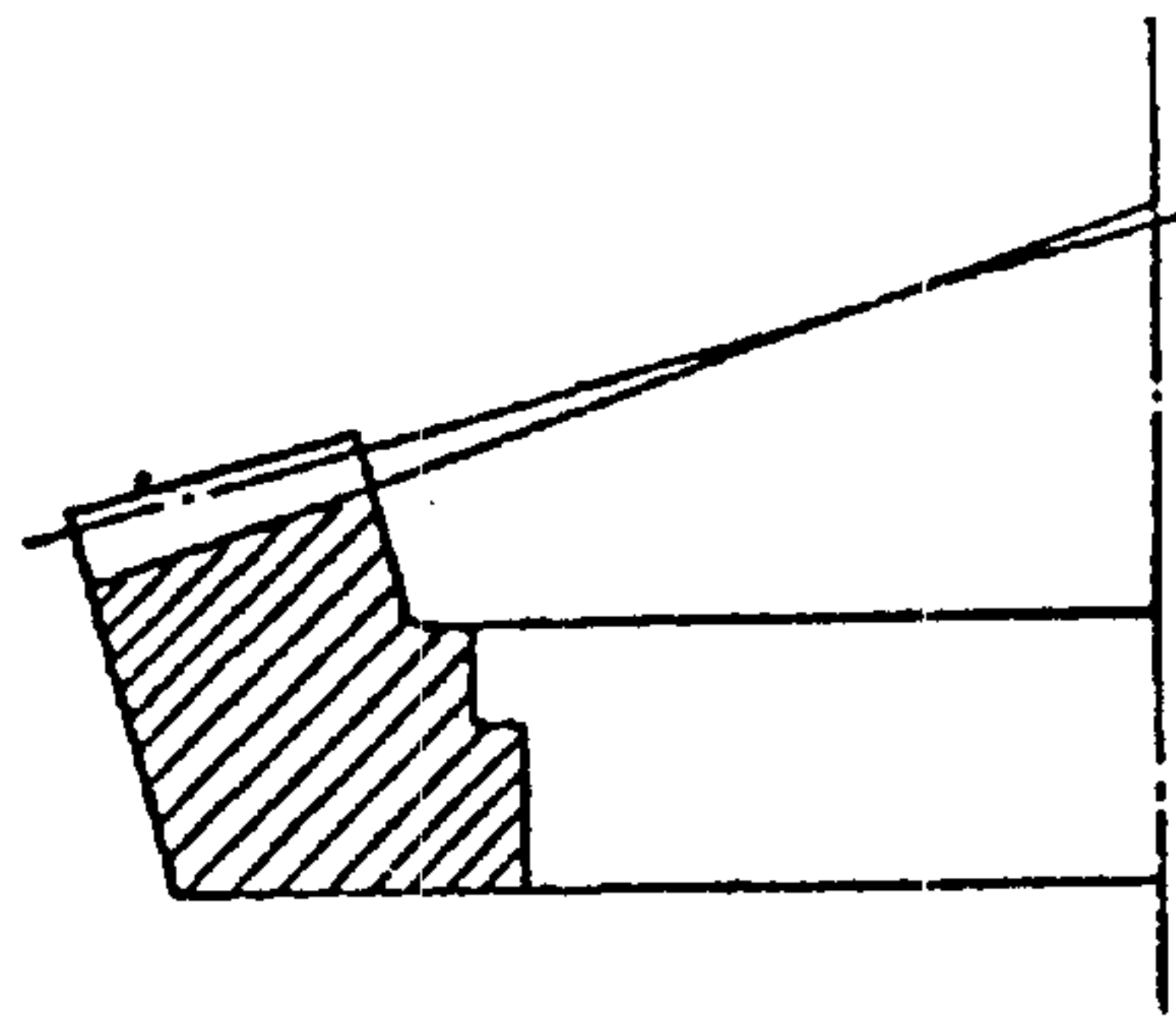


Fig 4. Trim

(4) Givn

It is a taper terminology in case that a tooth proportion is given by computer calculation.

(5) Plld

It is the case that a depth proportion is parallel, and generally used in the shaft angle of below 20° .

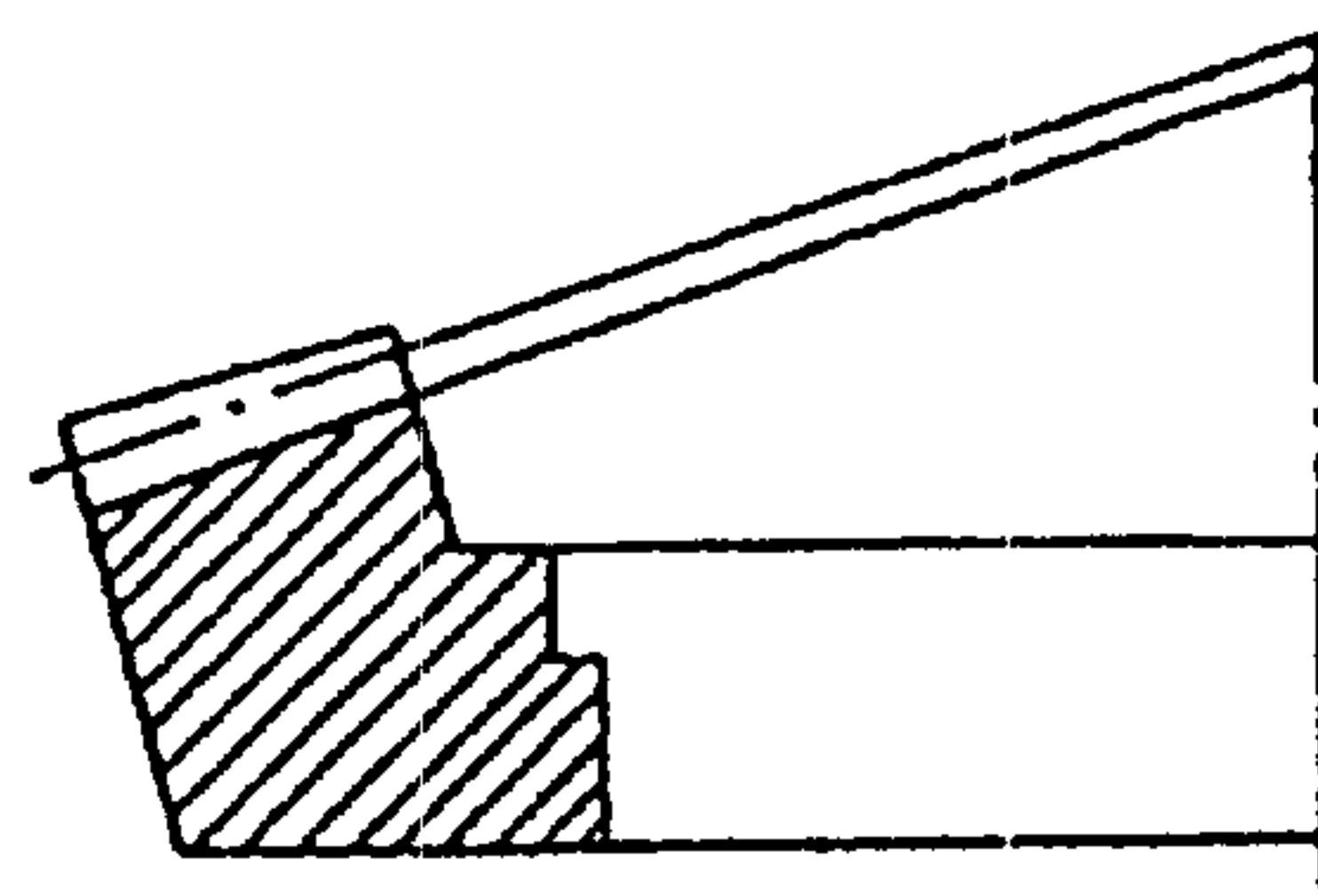


Fig 5. Plld

(6) Depthwise taper

Depth variation of a tooth in longitudinal direction that measured at the vertical to a pitch surface

(7) Space width taper

The variation of a tooth space in longitudinal direction of a tooth

(8) Slot width taper

Width variation in longitudinal direction of a tooth that measured at a root plane

It is called a point width taper, and a non-generated gear is same with a space width taper, but not same with a generated gear and pinion.

(9) Thickness taper

It is the thickness variation of a tooth in longitudinal direction, and measured at a pitch surface.

(10) Duplex taper

The state that a slot width taper in a pair of gears is zero (Spread blade taper)

A duplex taper is allowable at a STD depthwise taper or zero depthwise taper.

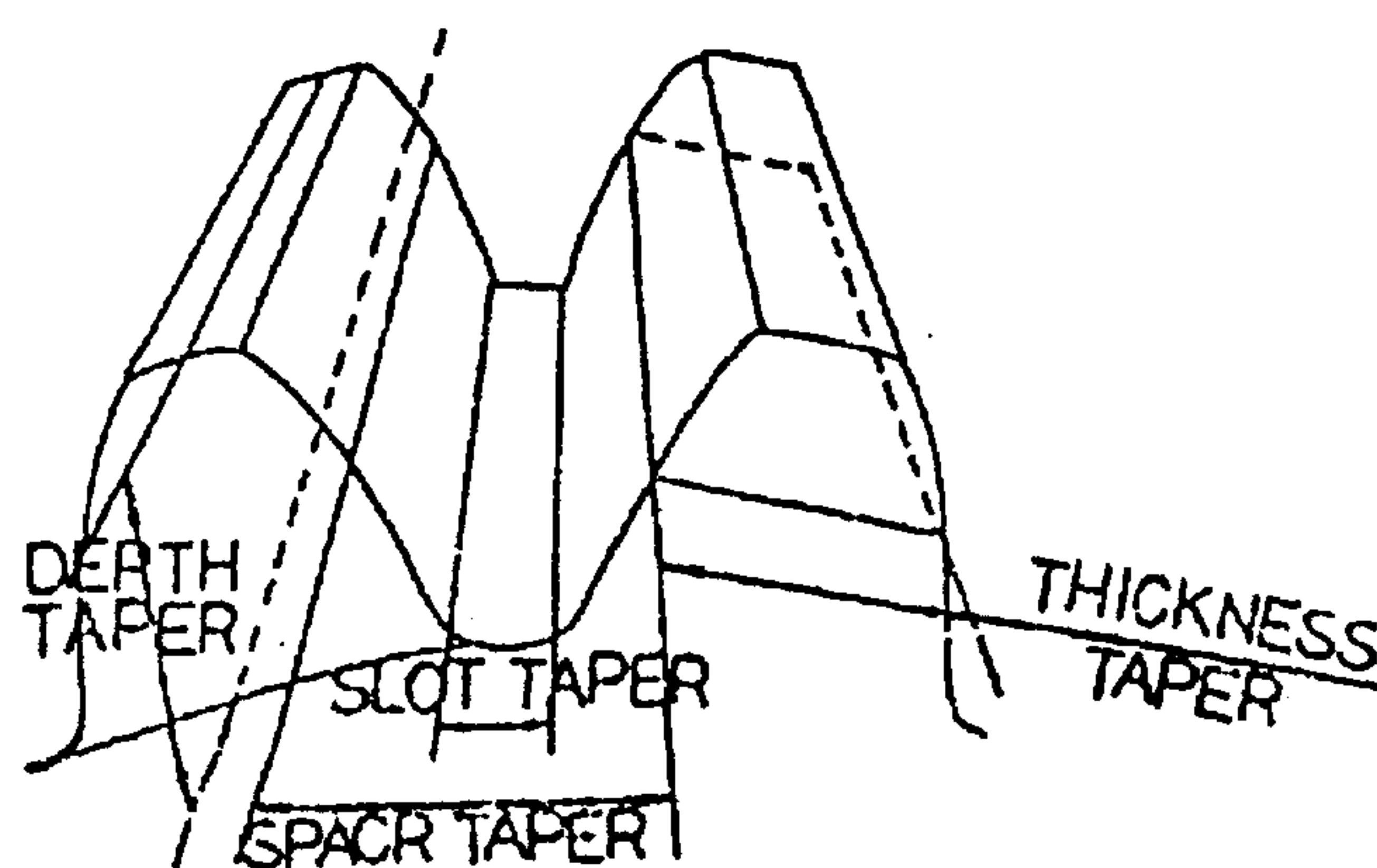


Fig 6. Tooth taper

3.18 Cutting method

It is applicable for the cutting method of a gear.

The calculation method of a slot width varies as the cutting method of a gear, so it has to be regulated.

(1) SB (Spread blade method)

It is the cutting method that separate cutters cut the both sides of a gear slot simultaneously. Undoubtedly, the slot between a large end and small end has the same width.

(2) STSS (Standard single side method)

It is the cutting method that separate cutters with different cut setting cut each side of a gear separately. In this case, the width of a slot tapers toward the center of a cone.

3.19 Pressure angle : ϕ A

(1) The angle between the vertical line to a tooth surface and tangent line of a pitch circle is 20° for a normal spiral bevel gear and 19° for a hypoid gear. For a truck, the angle of $20.5^\circ \sim 25^\circ$ is generally used.

(2) Because a large pressure angle produces the large thickness of a tooth, the strength of a gear increases. For the pressure angle of a passenger car, the driving comfortableness is more emphasized than the strength. So a contact ratio becomes large to make the pressure angle of a pinion drive side more small than that of a coast side.

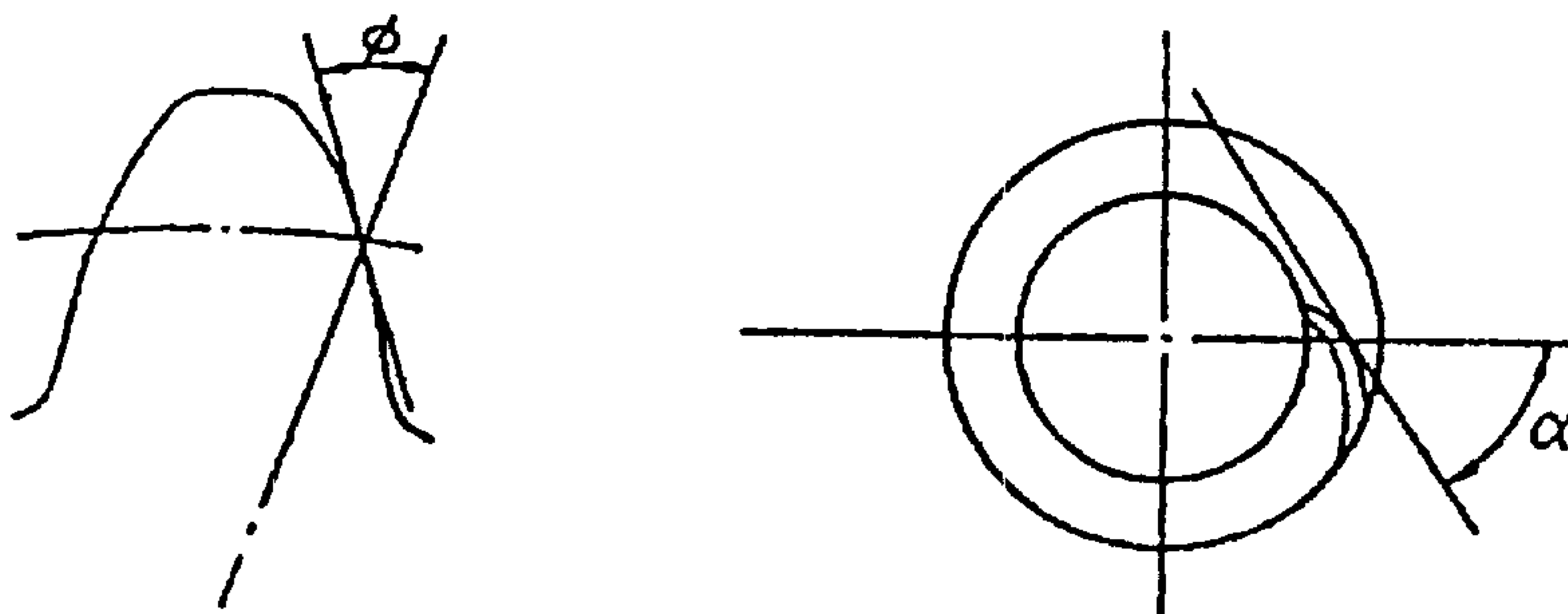


Fig 7. Pressure angle

3.20 Transverse contact ratio (m_p)

The ratio between the length of a action line and base pitch

$$(1) m_p = \frac{\text{Active length of contact}}{\text{Base pitch}}$$

$$(2) \text{Base pitch} = \text{circular pitch} \times \cos \phi$$

(3) The m_p in this chapter is measured at a spur gear and bevel gear.

(4) Appropriate value : 1.1 ~ 1.5

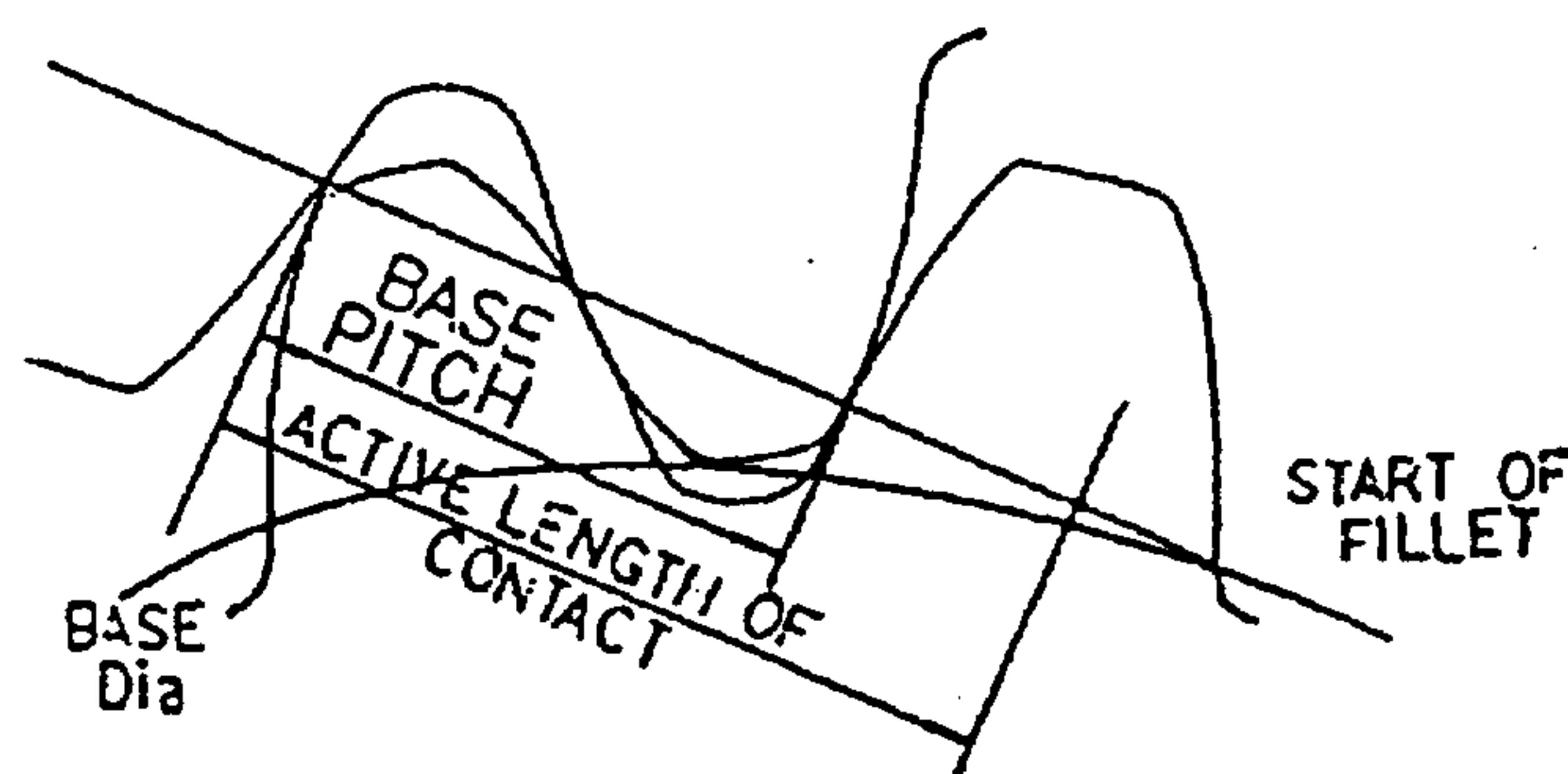


Fig 8. Transverse contact ratio

3.21 Face advance ratio (m_f)

The ratio between a face advance and circular pitch

$$m_f = \frac{\text{Face Advance}}{\text{Circular Pitch}}$$

$$= (0.3865 \tan \phi - 0.0171 T \tan^3 \phi) \cdot F \cdot Pd$$

Here, ϕ : Spiral angle

F : Face Width (Inch)

Pd : Diametral Pitch