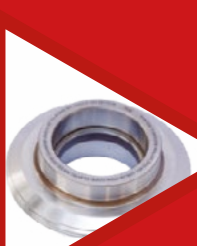


GEAR CUTTING TOOLS

CONTENTS

QUALITY ASSURANCE SYSTEM

MATERIAL PROCUREMENT

The material is procured directly from world-renowned manufacturers like Bohler Era Steel, Nachi etc

MATERIAL IDENTIFICATION

The stored raw materials are identified by color code by applying colors on the face as well as the length of stored material. In addition to the color code, every raw material bar is given a unique identification number. The record of the identification number is maintained to facilitate identification of supplier as well as material. The unique identification number of the bar is kept intact until the whole length of the bar is consumed.

SHELF LIFE

The raw material is stored in iron racks. Since the inventory of the material is maximum three months there is no need for any measures for control of shelf life etc. Prior to finishing, tools are sand-blasted to remove any rusting agents. After grinding and finishing tools are applied rust preventives and are securely packed in polythene bags and cardboard boxes.

CALIBRATION

Periodic calibration of the measuring instruments and testing equipment done as per BIS with the help of master gauges and meters or from some outside agencies

PROCESS CONTROL (HEAT TREATMENT)

The temperature of the heat treatment furnace is being controlled with the help of Digital Temperature Indicators and Controllers, Infrared Radiation Pyrometers and Optical Pyrometers.

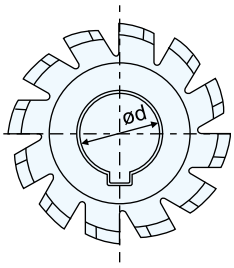
INTERNAL INSPECTION

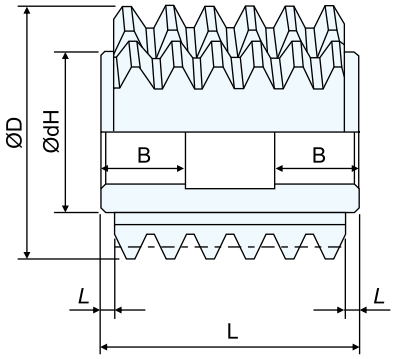
The inspection of the tool to be produced is being done at every stage of machining by keeping necessary Finishing/ Grinding margins and expansion tolerances during heat treatment. After heat treatment, the tools are ground to close tolerances as per standard specifications or as per specific requirement of the customer as per drawings etc.

MAINTENANCE OF QUALITY RECORDS

The maintenance of quality records for special as well as standard tools manufactured as per customers drawings and specifications are being maintained by preparing drawings and by keeping a record of the same by giving specific job/reference number to facilitate repeated orders.

GEAR AND INVOLUTE SPLINE HOB

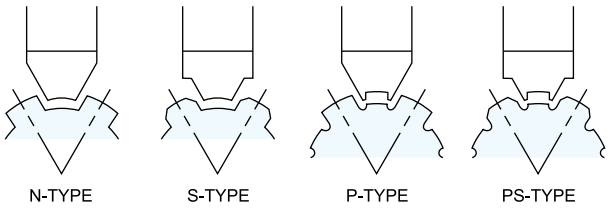




sizes as per DIN-8002B

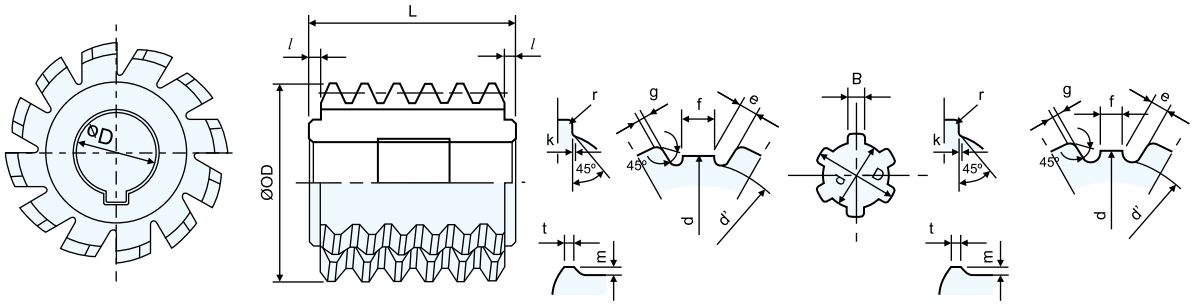
Module	Outside dia øD	Length L	Bore diameter ød	Hub length	Gashes
1	50	31	22	3	14
1.25			(3/4")		
1.5	56	38	22	3	12
1.75			(3/4")		
2	63	46	27 (1")	3	12
2.25	70	56	27 (1")	3	12
2.5					
2.75					
3	89	69	32 (1 1/4")	3	12
3.25					
3.5					
3.75	90	78	32 (1 1/4")	4	12
4					
4.5	90	78	32 (1 1/4")	4	10
5	100	88	32 (1 1/4")	4	10
5.5					
6	110	108	32 (1 1/4")	4	10
6.5					
7					
8	125	138	40 (1 1/2")	4	10
9					
10	140	170	40 (1 1/2")	5	10
11	160	180	50 (2")	5	9
12	170	195	50 (2")	5	9
13	180	210	50 (2")	5	9
14	190	225	50 (2")	5	9
15	200	235	60 (2 1/4")	5	9
16	210	248	60 (2 1/4")	5	9
18	230	270	60 (2 1/4")	5	9
20	250	296	60 (2 1/4")	5	9

STRAIGHT SIDED SPLINE HOB



Title of Spline of	Specification of HOB			Dimension of Each Spline Type									
				I Type					II Type				
	Outer Diameter øD	Full Length L	Inner Diameter	Number of Splines N	Minor Diameter d	Major Diameter D	Width B	Chamfer-ing g	Number of Splines N	Minor Diameter d	Major Diameter D	Width B	Chamfer-ing g
11	60	60	19.05						6	11	14	3	0.3
13										13	16	3.5	
16										16	20	4	
18										18	22	5	
21	75	75	27 (25.4)							21	25	5	
23				6	23	26	6	0.3		23	28	6	
26					26	30	6			26	32	6	0.4
28					28	32	7			28	34	7	
32					32	36	8			32	38	8	
36					36	40	8			36	42	8	
42					42	46	10			42	48	10	
46	95	95	32 (31.75)		46	50	12			46	54	11	0.5
52					52	58	14	0.4		52	60	14	
56	115	115			56	62	14			56	65	14	
62					62	68	16			62	72	16	
72	135	175	40 (38.1)		72	78	18			72	82	18	
82					82	88	20			82	92	20	
92	145	190			92	98	22			92	102	22	
32	75	75	27 (26.988)	8	32	36	6		8	32	38	6	0.4
36					36	40	7			36	42	7	
42					42	46	8			42	48	8	
46	95	90	32 (31.75)		46	50	9			46	54	9	0.5
52					52	58	10	0.5		52	60	10	
56					56	62	10			56	65	10	
62					62	68	12			62	72	12	
72				10	72	78	12		10	72	82	12	
82	115	115			82	88	12			82	92	12	
92					92	98	14			92	102	14	
102					102	108	16			102	112	16	
112					112	120	18			112	125	18	

The values of Tip width (f), undercut width (e) and lug diameter (d') are decided as per DIN-5462, DIN-5463 or DIN-5464.

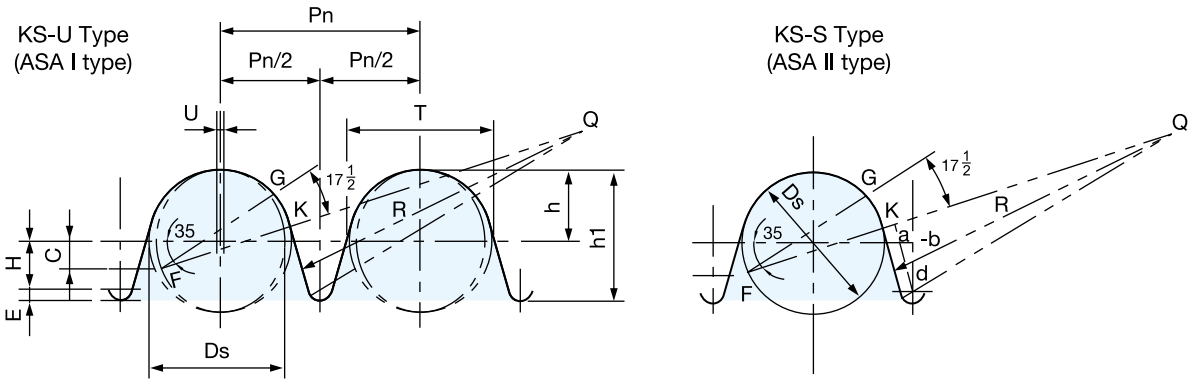


SPROCKET HOB

[mm]

Types of Chain Sprocket			HOB Dimensions			
KS, ASA I & II	CP	RD	Outer Diam-eter D	Full Length L	Inner Diameter (d)	
					A [m]	B [in]
RS25	6.35 (1/4")	3.3	60	60	22	22.225
35	9.525 (3/8")	5.08	65	65		
35	9.525 (3/8")	6.35	65	65		
40	12.7 (1/2")	7.77	75	75	27	25.4 (26.988)
40	12.7(1/4")	7.95	75	75		
40	12.7 (1/2")	8.5	75	75		
50	15.875 (5/8")	10.16	85	90		
60	19.05 (3/4")	11.907	90	105		
80	25.4(1")	15.875	110	125	32	31.75
100	31.75(1 1/4")	19.05	120	140		
120	38.1 (1 1/2")	22.225	130	170		
140	44.45 (1 3/4")	25.4	160	190	40	38.1
160	50.8 (2")	28.575	170	210		
180	57.15 (2 1/4")	35.72	190	240		
200	63.5 (2 1/2")	39.688	210	260	50	50.8
240	76.2 (3")	47.625	240	3100		

CHAIN AND HOB TOOTH PROFILE (NORMAL ANGLE)



KS-U Type

Pn = Normal pitch of hob = 1.011 X Chain Pitch
Ds = Minimum diameter of basic coverture of tooth bottom = 1.005 x Roller + 0.08
U = 0.07 (Chain Pitch-Roller diameter) + 0.051

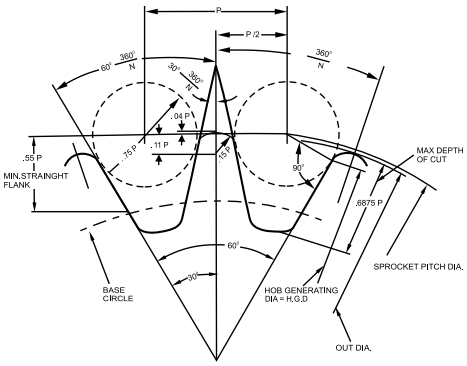
KS-S Type

U = 0

SILENT CHAIN SPROCKET HOB

For tooth profile; ASA B29.2-1950 and UDC NO.621.855

Chain Pitch	Hob Number	Standard Number of Teeth	Range of Tooth Profile of Hob
SC3 = .375″	1	20	17-23
SC4 = .500″	2	28	24-32
SC5 = .625″	3	38	33-43
SC6 = .750″	4	51	44-58
SC8 = 1.000″	5	69	59-79
SC10 = 1.250″	6	95	80-110
Sc16 = 2.000″	7	100	111-150

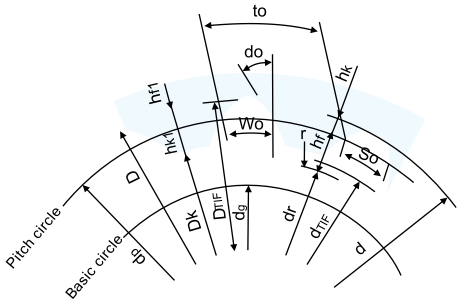


SERRATION HOB

Following is standard tooth profile of KS-B-2007 Involute Serration.

ORDER SPECIFICATION

Order specifications for Involute Serration Hob are the same as that of Involute Spline Hop. For overall dimensions, please refer to Involute Spline Hop described in page page 4. Basic formula of each part are as follows.



Item		Symbol	Calculation Formula of Serration Part
	Module	m	6 kinds; 0.5, 075, 1.0, 1.5, 2.0, 2.5
	Teeth	z	10~60
	Pressure Angle	α_0	Pressure Angle on pitch circle $\alpha_0 = 45°$
	Tooth Height	h_t	0.8m
	Shift	χ	0.1m
	Major Diameter	d	d=(z+0.8+2χ)m=(z+1)m
	Pitch	t_0	to = π . m
	Pitch Diameter (Pitch Circle Diameter)	d_0	dp= z .m
Inner Diameter Serration	Major Diameter	D	D=(z+1.4)m = d + 0.4 m
	Minor Diameter	Dk	Dk = (z-0.6)m = d -1.6m
	Limit Diameter of Involute	DTIF	DTIF = (Z+1.1)m
	Addendum	hk1	hk1=(0.4-χ)m=0.3m
	Dedendum	hf1	hf1=(0.6-χ)m=0.7m
	Width of Arc of Groove on PCD	Wo	$W_o=(\frac{\pi}{2}+2\chi \tan\alpha_0)m = (0.5\pi+0.2)m$
Outer Diameter Serration	Major Diameter	d	d=(z+0.8+2x)m = (z+1)m
	Minor Diameter	dr	dr=(z-1)m=d-2m
	Limit Diameter of Involute	dTIF	dTIF = (Z-0.7)m
	Addendum	hk	hk=(0.4+x)m=0.5m
	Dedendum	hr	hr=(0.6-x)m=0.5m
	Thickness of Arc of Tooth on PCD	So	$S_o=(\frac{\pi}{2}+2x\tan\alpha_0)m=(0.5\pi+0.2)m$

RATCHET HOB

The importance o designing ratchet should be recognized considering its indispensable functions. Following are to be considered in designing ratchet.

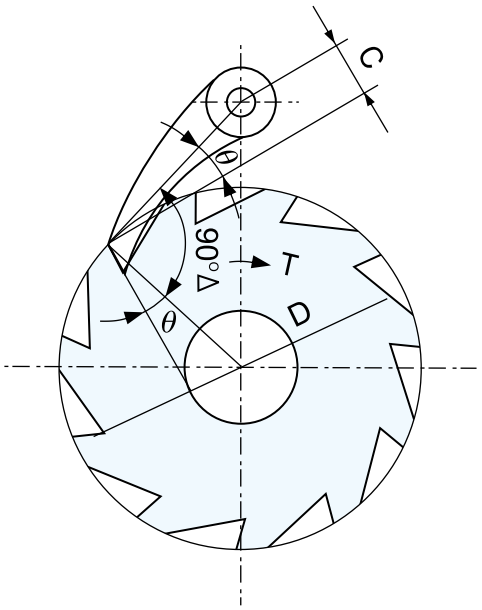
- Force impacted on the sustaining point of the pawl must be minimal.
- Angle (*Θ*) of contacting side of pawl when it stops must be larger than fractional angle.

Under normal dry ambience Θ=12-20°
Under lubrication Θ=10-15°

Things to accompany with Order

When ordering Ratchet Hob, please provide following data:

- Detailed Drawing of Ratchet Profile
- Overall dimensions of Hob (Outer Diameter x Inner Diameter x Length)
- Specification of Hob - Number of Threads and Blades, etc.

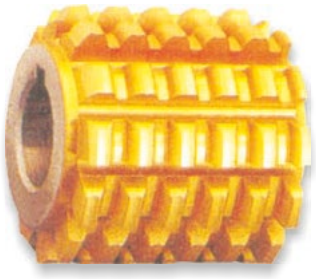


TIMING PULLEY HOB

ORDER SPECIFICATION

Timing belt varies in its tooth profile depending upon manufacturer. As such tooth profile data is required along with order specification.

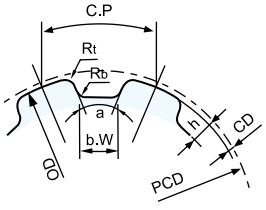
- Belt Specification (Model Type and Pitch)
- Belt Manufacturer
- Pulley Teeth
- Detailed Description and Drawing of Pulley Teeth
- Size of Exterior Look of Hob ordered (outer diameter x inner diameter x full length, etc.)
- There is no limit in designing pulley hob beyond 24T for using it for common purpose in the industry in general.



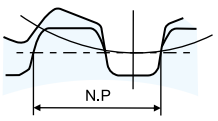
COMMON DIMENSION TABLE

Hob Number	Number of Pulley Teeth	Standard Tooth for Design
1	More than 40	40
2	25-39	25
3	17-24	17
4	12-16	12
5	9-11	9

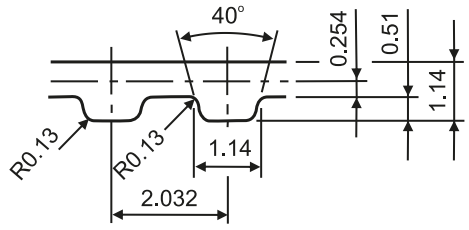
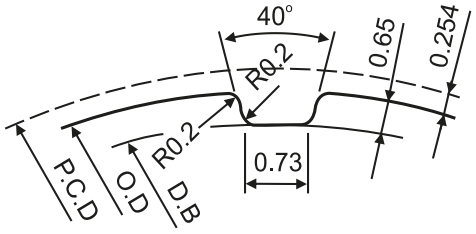
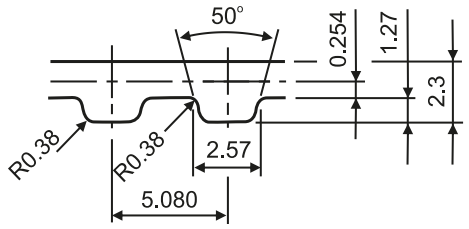
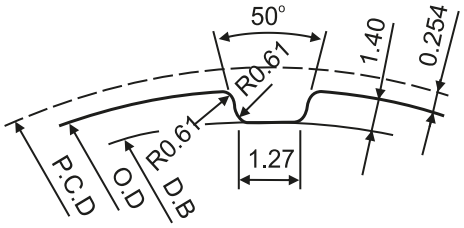
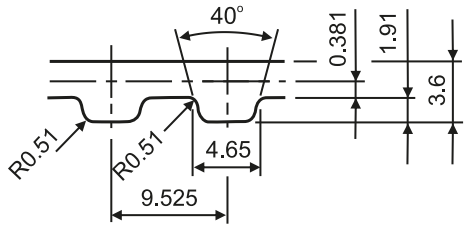
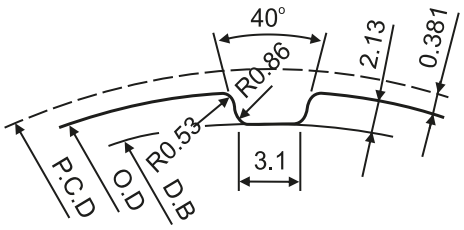
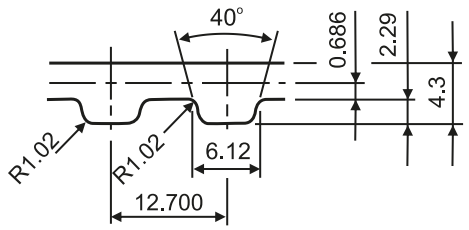
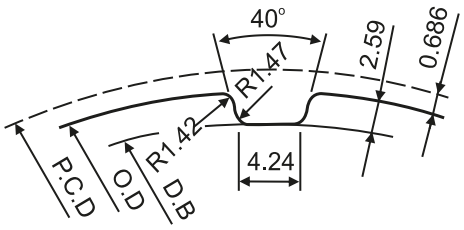
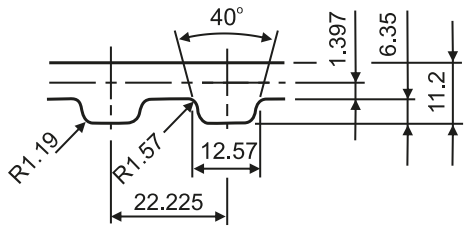
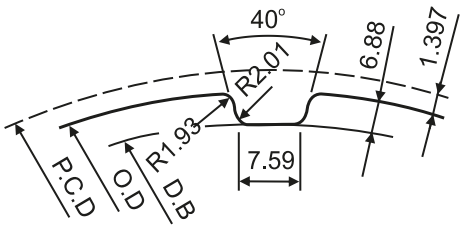
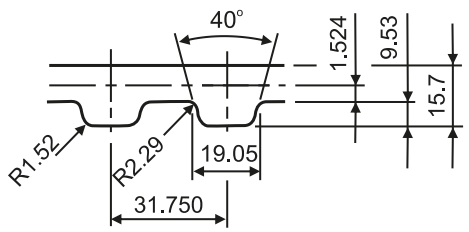
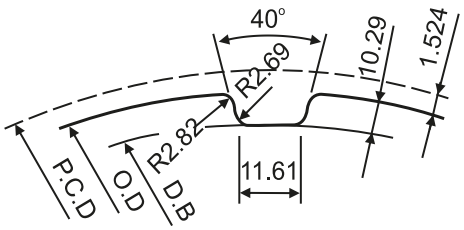
Shape of Pulley



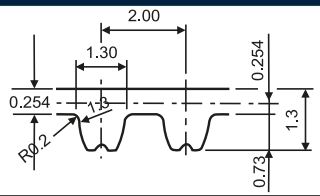
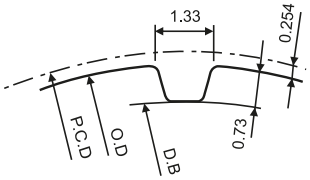
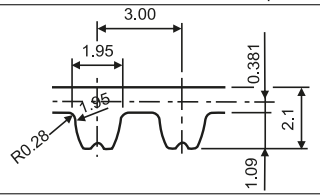
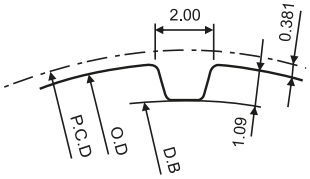
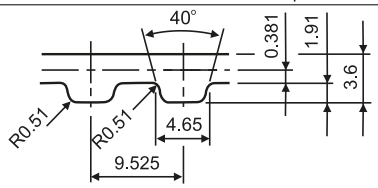
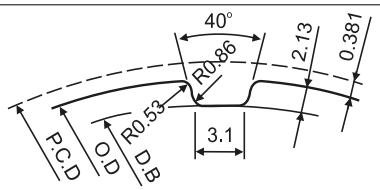
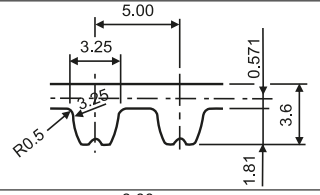
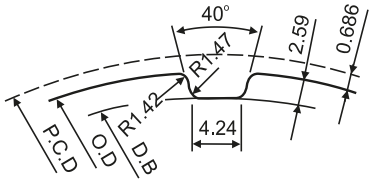
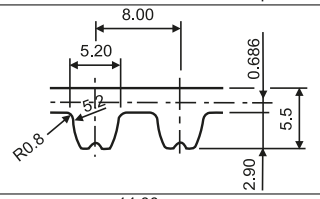
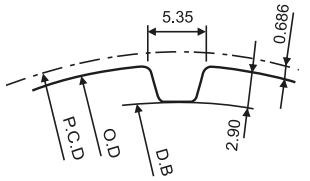
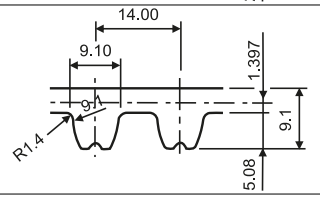
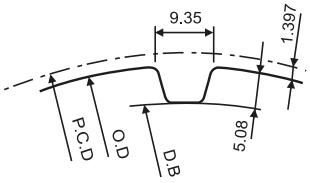
Shape of Hob



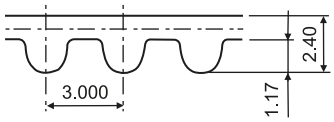
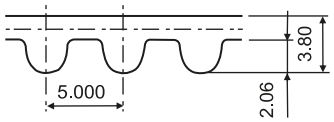
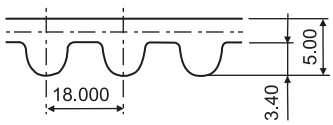
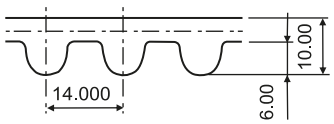
TIMING BELT PROFILE

Type	Timing belt profile	Timing pulley profile
MXL		
XL		
L		
H		
XH		
XXH		

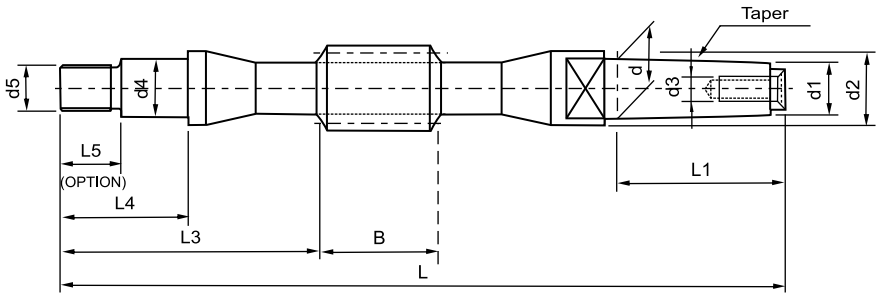
TIMING BELT PROFILE

Type	Timing belt profile	Timing pulley profile
STS 2M		
STS 3M		
STS 4.5M		
STS 5M		
STS 8M		
STS 14M		

TIMING BELT PROFILE OF HTD TYPE

HTD	HTD 3M 	HTD 5M 
	HTD 8M 	HTD 14M 

WORM WHEEL HOB



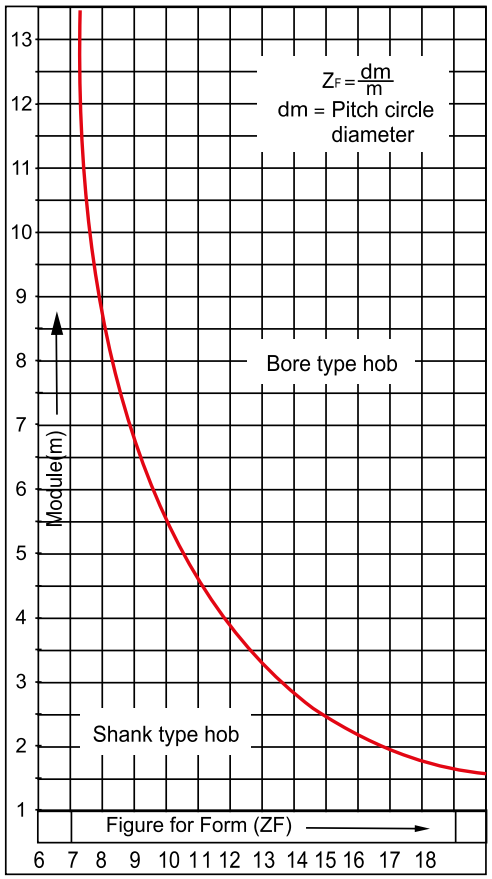
Selection Table for VWorm Hob Type

Worm Data is mostly influential on designing Worm Hob, so that when ordering worm hob, data of worm is required.

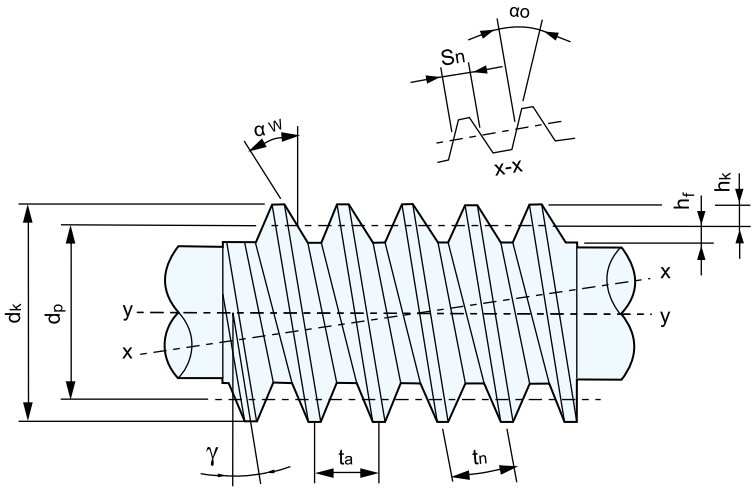
While ordering please choose type, profile and data among the following options, and furnish with Worm Data (drawing).

- Select either Bore Type or Shank Type
  - In cas of Shank Type, present specification of Shank, along with direction of rotation of Hob.
- Select standard of tooth profile; ZI, ZK, ZN, ZA, and others
  - In general, worm hob is manufactured by the standard profile of ZK and ZI
- Worm Data
  - Axial or Normal module
  - Normal pressure angle
  - Worm out diameter and pitch circle diameter
  - Lead angle and direction
  - Number of worm threads
  - Centre Distance and Backlash.

For General bore type and shank type hobs, please refer to the graph on the right.

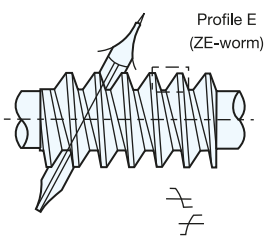


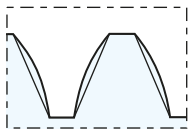
WORM WHEEL HOB



x-x	:	Normal Section	α_o	:	Normal Pressure Angle
y-y	:	Axial Section	α_w	:	Axial Pressure Angle
d_p	:	Pitch Diameter	h_x	:	Addendum
d_k	:	Outer Diameter	h_i	:	Dedendum
t_n	:	Normal Pitch	m_n	:	Normal Module
t_a	:	Axial Pitch	m_s	:	Axial Module
S_n	:	Normal Tooth Thickness	Z_w	:	Number of Threads
γ	:	Helix Angle (Right/Left)	Z_2	:	Number of Teeth of Worm Gear

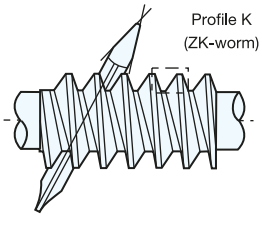
FLANK FORMS





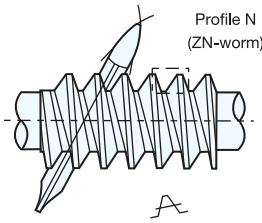
ZE Tooth Profile (ZI)

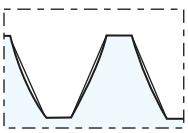
Tooth profile of worm shaft is involute wave.



ZK Tooth Profile

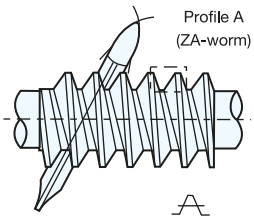
A tooth profile ground by giving standard pressure angle.

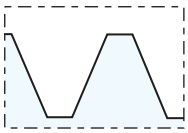




ZN Tooth Profile

A tooth profile having normal profile in straight line.





ZA Tooth Profile

A tooth profile having axial profile in straight line.

SOLID CARBIDE HOBS

In order to broaden the product range and satisfy the customer's needs, TIZ has installed dedicated Machines for Solid Carbide Hobs up to Class "AAA" and can manufacture and supply the same ranging from 0.15 Module to 3 Module.

For Hobs, three different solid carbide types are employed: grade "K" grade "P" and "G".

Each grade is having different composition depending on its final use.

In certain applications Solid Carbide Hobs are preferred to PM Steel Hobs where Feeds & Speeds required are on higher sides.

Solid Carbide Milling Cutters can also be manufactured.

FORM RELIEVED MILLING CUTTERS

TIZ offers precision form relieved ground or unground profile cutters ranging from standard single angle, double angle, convex/concave cutters to most complex intricate profile cutters like end mili type gear cutters, spline milling cutters, turbine blade profile milling cutters etc.

These milling cutters are made out of high alloy super high speed steels; with precision ground or unground forms; with straight or helical flutes for shear cutting; continuous or intermittent (staggered) cutting teeth; with or without chip breakers; radial, positive or negative rake tooth faces; with radial, axial or undercutting clearances; individual, gang or solid sections. As cutter teeth are cam relieved, only rake faces need to be sharpened without changing the tooth form through their full life. Cutter accuracy is maintained as long as they are accurately resharpened. This simplifies tool maintenance and provides more consistent quality. These cutters provide high degree of accuracy and efficient cutting geometry and hence ordinary cutters can not be comparable in no way with these TIZ special cutters. Some important applications of these cutters are highlighted below:

- Spur gear teeth milling for specific number of teeth or in sets of 8 and 15 cutters to IS or BS standards.
- Sprocket teeth milling cutters, precision ground or unground profile.
- Rack teeth milling of highest accuracy, single or multistrand, precision ground or unground profiles.
- Worm thread milling, roughing or finishing, with and without chamfer ground or unground form.
- Spline milling on universal or HURTH type machines.
- Special serration milling on machine chuck-jaws, automobile con-rod jaws etc.
- Special narrow & deep groove milling on automobile con-rods.
- Serration milling cutter for flanged yoke and companion flange

HI-BITE MILLS, "DO-ALL" CUTTERS

Heavy duty cobalt bearing super HSS Hi-Bite multi purpose mills, shank type or shell type designs are manufactured in various diameters as per DIN 844 and DIN 845B or to customers specific requirement and provide the following advantages:

- Most versatile milling cutter.
- Ability to take heavier cuts at higher speeds with less chatter and vibration.
- High rate of metal removal with minimum Horse Power.
- Removes metal at the higher rate with less deflection than conventional end mills, particularly in the longer lengths.
- Tooth form provides excellent heat dissipation during heavy cutting operations.
- Unique computer generated tooth profile designed for excellent chip breaking characteristics.
- Wide applications viz : die-sinking, horizontal boring, universal milling, CNG machining centers, drilling machine etc...
- Also supplied with special large profiles with helical flutes for finish die sinking, form milling or turbineblade milling etc...
- The cutters are form relieved which means simplified resharpening with no change in tooth profile. Many mare resharpenings possible as compared to ordinary end mills.

Maximum profile length	300mm
Maximum cutter diameter	220 mm
Involute cutters for external and internal gear teeth	4 module to 48 module

SPECIAL TOOLS

Special tools programme includes rack type shaper cutters used for shaping spur, helical or herringbone gears on Maag or Sunderland shaping machines; profile rollers for cold rolling on Grab machines; hi-bite mills with special design chip breakers etc.

GEAR SHAVING CUTTERS

Manufacturing of Gear Shaving Cutters such as Conventional Diagonal Underpass and Plungecut is undertaken by TIZ. Materials available for Gear Shaving Cutters include Conventional & Powder Metallurgy High Speed Steels. In addition, Resharpening/Refurbishing of Gear Shaving Cutters is also being carried out. Inspection Reports are being provided with every individual cutter.

Range	1 Module to 0 Module
Width	15mm to 65mm
Diameter	100mm to 300mm
Helix Angle	0° - 0.45°

GEAR SHAPING CUTTERS

TIZ manufacture Gear Shaping Cutters in Module, DP and CP Series: Spur as well as Helical Gear Shaper Cutters can be supplied in Disc, Hub, Deep Counter Bore, Shank and Button Type Varieties.

Material used is Conventional and Powder Metallurgy Grades of High Speed Steel, Accuracies are as per DIN 1829 Standard Class 'AA and Class 'A'.

Profile Modifications including Topping, Semi-Topping, Protuberance, Flat or Fillet Roots can be provided if necessary.

GEAR DEBURRING CUTTERS

These Cutters are used in conjunction with Gear Chamfering Cutters to remove the burrs formed during teeth cutting Material used in the manufacturing generally HSS M 2. These Deburring cutters for Samputensili Machines are available in both standard as well as customized forms.

- Standard Tools for gears with parallel faces
- Serrated Tools for gears with inclined faces

GEAR CHAMFERING CUTTERS

TIZ manufacture Gear Chamfering Cutters to chamfer the flank edges of Spur and Helical Gears. The Chamfering Operation prevents edge distortion during Heat Treatment and protects the profile during handling. Chamfering Cutters are mainly used for Chamfering of Gears by Automobile Industry. These Cutters can chamfer both the flanks of a gear at a time. Same set of Chamfering Cutters can be used for similar gears having different face widths. The variation in the width of the gears is adjusted with the help of suitable spacers.

SPLINE ROLLERS

TIZ manufacture Spline Rollers for use on GROB Spline Rolling Machines. The rollers are manufactured out of best quality HSS. Material in Grades like M42, ASP 2030, ASP2052 & ASP 2060.

Spline Rollers are the best tools to manufacture Spline Shaft Components where Hobbing is not possible. Spline Rollers are the best tools for mass production of Splined Shaft Components.

Two Rollers located at 180 degree of each other and rotating around individual Axis form the Splines.

FORMING ROLLERS

TIZ manufacture Forming Rollers for Air-Conditioning Compressor Electromagnetic Clutch Pulleys in Single and Multi-Grooved.

Profiles as per requirements of the users.

These Forming Rollers are used by Manufacturers of Automotive Air Conditioning Units for forming of Pulleys by Rolling Process.

Raw Material used is SKD11. YXR3, YXR33 or equivalent grades.

SWAGING CUTTERS

These tools are forming tools used to taper Clutch Teeth of Synchromesh Gear Boses.

TIZ manufacture Swaging tools according to customer needs and requirement.

Swaging Tools are manufactured and supplied in Integral as well as Split Type Designs.

POWER SKIVING CUTTERS

New technology can now allow high speed synchronous movement between the tool and the part which enables a part cut on the cross axis' by the tool. This type of tool can be used on dedicated Skiving Machines and Modern 5 axis Machining Centres.

Tools can now be manufactured from more Hard-Wearing Materials such as Mc90 and Carbide.

A full Re-grinding service is available for all Skiving Tools, including normal Helical Sharpening and lip and Chamfer Helical Sharpening. Also available is a precision edge preparation and full Re-coating services.

BROACHES

Broaching means opening up. Broaching is a manufacturing process in which a Cutting Tool having multiple traverse edges is pushed or pulled through a hole or over a surface to remove metal by axial cutting. Each tooth removes a small fraction of work piece material. The work piece can be finished to size in a single or multiple passes of the broach through a hole/surface. The Tool has a major influence on the surface finish achieved. The design of the broaching tool depends upon the material, the shape and the quantities of the work piece that are to be broached.

TIZ manufacture Push & Pull Type Broaches in Conventional as well as Powder Metallurgy High Speed Steels in following Profiles:

SPLINES

- Straight Sided
- Involute
- Serrations
- Trapezoidal

INTERNAL HOLE

- Square
- Round
- Rectangular, Hexagonal
- Irregular Shapes etc.

KEYWAY

- With or Without Chamfer
- Convex / Concave
- Combined Round & Single Keyway etc

SURFACE BROACHES

Surface Broaching is a generic term used in the broaching industry to refer to broaching any external surface of a place part.

Surface broaching is fast and typically more efficient than milling, Multiple dimensions can be cut simultaneously. Surface Broaching is most easily adopted to vertical or High Speed Broaching Machines. Surface Broaching is fast, cost effective and accurate.

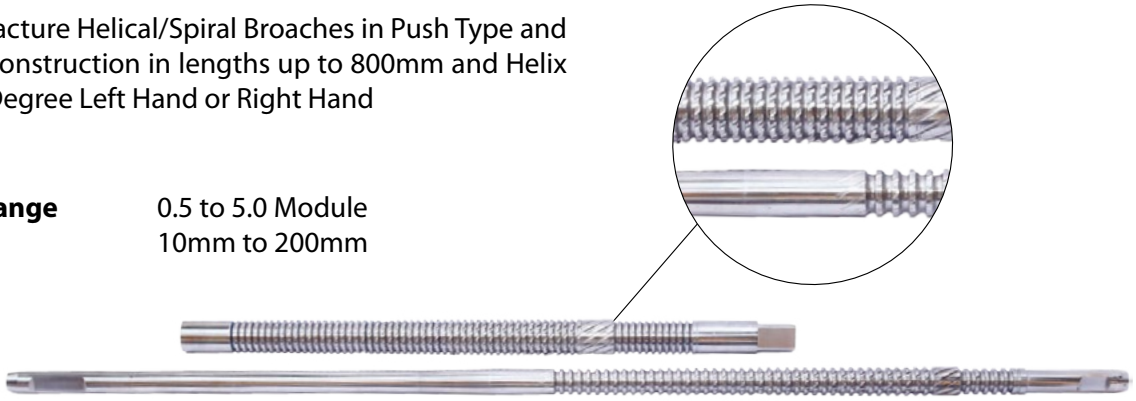
TIZ manufacture best quality of Surface Broaches as per customer's requirements and specifications.

HELICAL BROACHES

A Helical/Spiral Broach a type of Broach that creates an internal Spiral in Pre Drilled Hole.

TIZ manufacture Helical/Spiral Broaches in Push Type and Pull Type construction in lengths up to 800mm and Helix Angle 45 Degree Left Hand or Right Hand

Module Range 0.5 to 5.0 Module
Diameter 10mm to 200mm



SPLINE PUNCHES

Blind Spline Tools are used in applications that do not allow Internal or External Broach to pass through or Over a part.

TIZ manufacture Punches to produce Internal Splines for mass production by Cold Forging or Forming Process. The Punches can be manufactured and supplied to produce Spur as well as Helical Components. Size Range from 0.5 Module to 4 Module in Diameters 12mm to 200mm.

The Punches are manufactured and supplied in Ground Form duly inspected on Klingelnberg P26 or P40 CNC Machines in different HSS Grade Materials of Customer's choice.

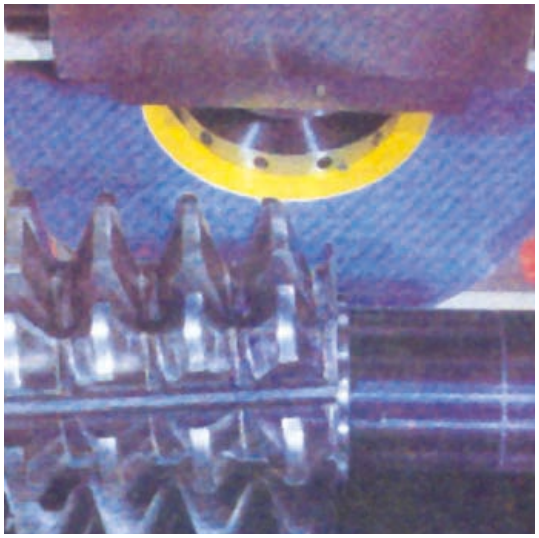
HEAT TREATMENT

Through decades of experience in producing highest quality tools made from different types of super HSS, TIZ has established guaranteed resources in HSS heat treatment technology. Heat treatment on Super HSS & HSS tools requires special skills & precautions, especially for long shank tools having varying cross sections.

State-of-the-art heat treating equipments and instruments added with skilled & specialized team assure delivery of uniform, consistent quality of treated tools.

When your tools are sent to TIZ for heat treating, you are assured of high quality services. Heat treatment services for SHSS or HSS tools on contract basis are also offered.

RE-SHARPENING - HOBS & SHAVING CUTTERS

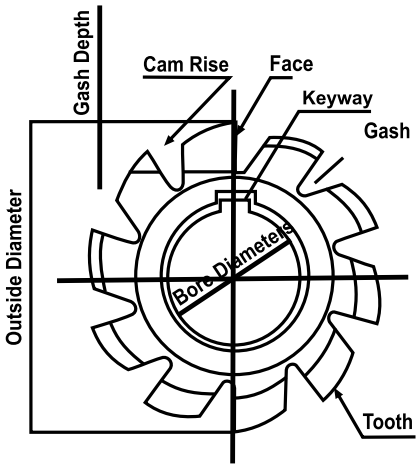


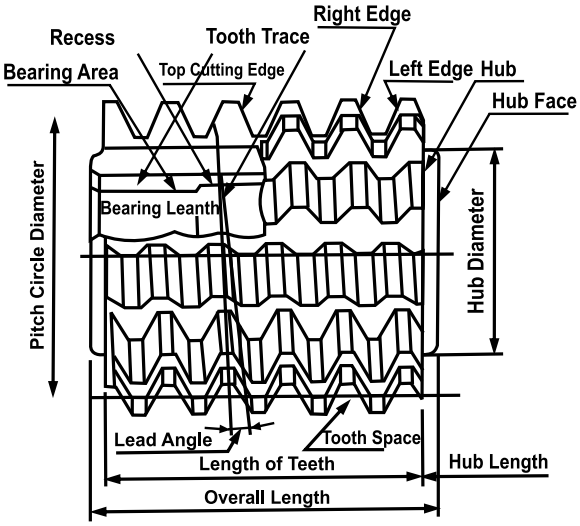
With the long experience and know-how gained during last 25 years working experience, TIZ tool sharpening, putting latest technology in the field, gives edge over others. Accurate resharpening of tools is of utmost importance for maintaining quality of machined components. A highest quality tool shall be rendered useless due to bad resharpening. Extra care is taken to maintain thermal & metallurgical stability of resharpened tools at TIZ. Every care is taken to avoid common tool sharpening problems such as true hob or cutter mounting on arbor, setting up to maintain desired rake faces, flute helix and correct flute indexing etc. When your hobs are sharpened at TIZ, you are guaranteed of accurate and consistent quality. TIZ also equipped to provide services of

Shaving Cutter Resharpening to our esteemed customers. We carry out the sharpening of Shaving cutters with straight profile, lead crowning and profile crowning.

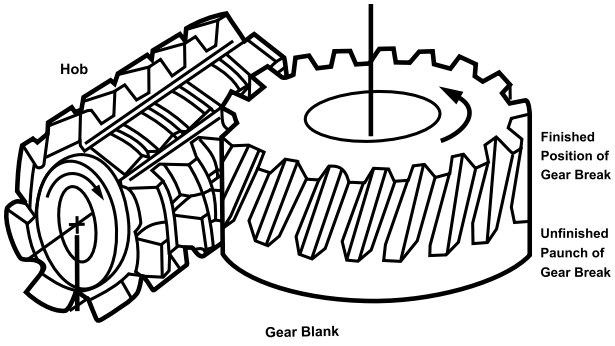
After resharpening, all parameters are checked on Klingelnberg Gear Tester P26 and protocol furnished.

HOB NOMENCLATURE

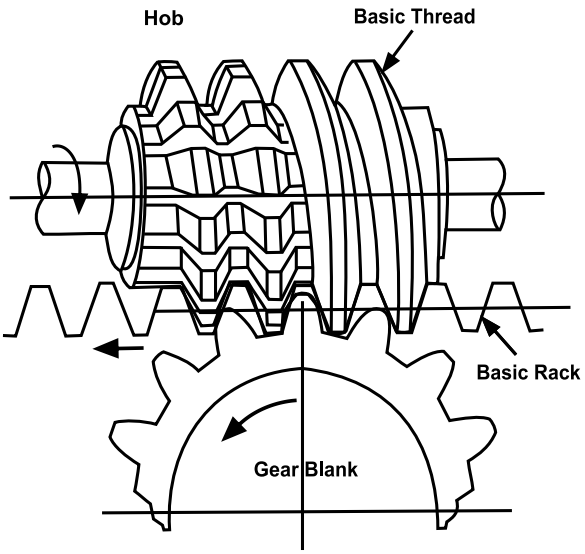




HOBBING PRINCIPLE

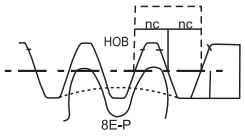
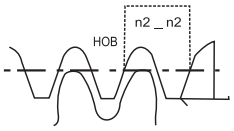
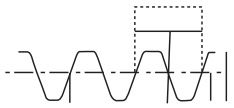
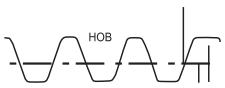
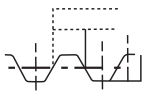
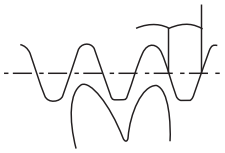


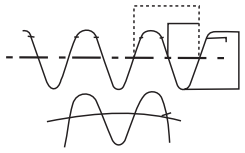
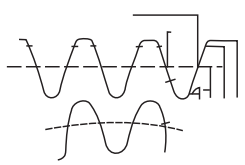
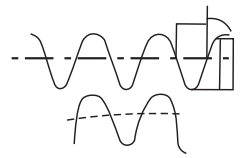
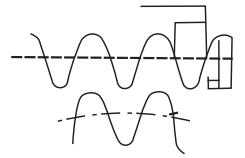
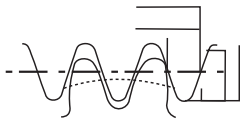
Hob Cutting



Hob Cutting Action

BASIC RACK TOOTH PROFILE (DIN 3972)

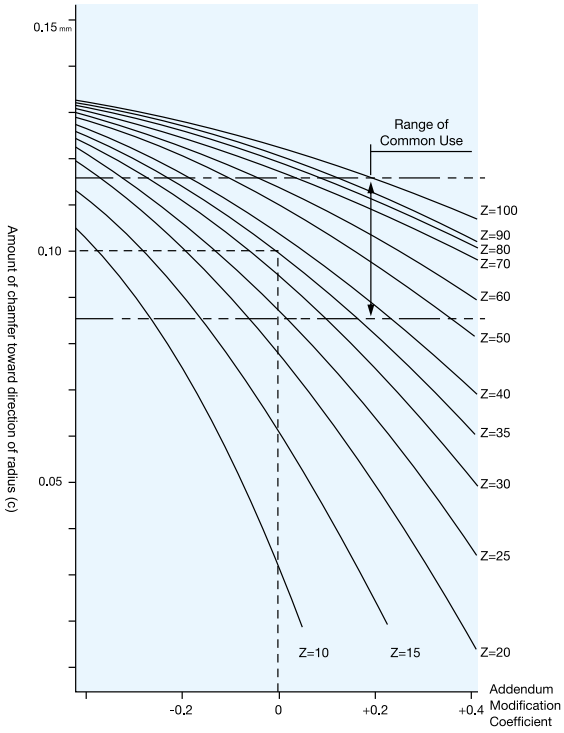
Type	Class Cation	Sym-bol	Basic rack tooth Profile	
FINISHING	STANDARD	FIN		PA= 20° or 14.5° hao= 1.25m D+F = 2.25m ho= 2.5m r = 0.2m - 0.39m
	SEMI-TOPPING	S-TOP		PA= 20° or 14.5° hao= 1.25m ho= D+F= 2.25m r=0.2m-0.39m Values of X, A3 & ho must be cal
	FULL-TOPPING	TOP		PA= 20° or 14.5° hao= 1.25m ho= D+F= 2.25m r=0.2m-0.39m
	STUB TOOTH	STUB		PA= 20° hao= o.am D+F = 2.25m ho= 2.0m r= 0.3m
	INVOLUTE SPLINE	STUN DIN5460		PA= 30° hao= 0.6m D+F = 0.6m ho= 1.2m r = 0.16m
	TIP MODIFICATION	TIP RELIEF		PA= 20° or 14.5° hao= 1.25m D+F = 2.25m ho= 2.5m r = 0.2m = 0.39m Relief= Tr=As per std. or as per requirement

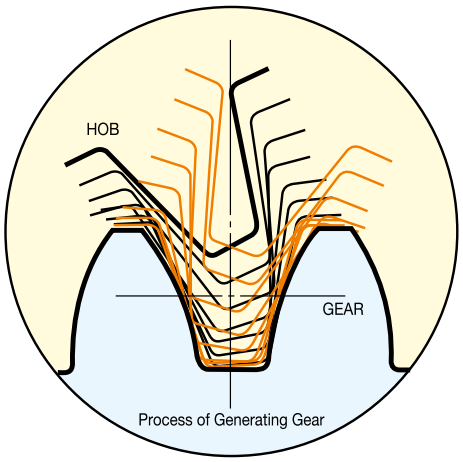
Type	Class Cation		Sym-bol	Basic rack tooth Profile	
PRE-FINISHING	PRE-SHAVING / PRE-GRNIDING	HIGH ADDENDUM	PER-S PER-G		PA = 20° or 14.5° hao = 1.35m So = tn/2 - (2 X FA) D+F = 2.35m r = 0.3m FA = As per chart or as per requirement.
		PROTUBERANCE	PS-P PG-P		PA = 20° or 14.5° hao = 1.4m So = tn/2 - (2 X FA) D+F = 2.4m ho = 2.6m r = 0.3m FA = As per chart or as per requirement.
		SEMI-TOPPING	PS-ST PG-ST		PA = 20° or 14.5° hao = 1.35m or 1.25m So = tn/2 - (2 X FA) D+F = 2.35m or 2.25m ho = 2.6m r = 0.3m FA = As per chart or as per requirement.
		PROTUBERANCE SEMI-TOPP	PSP-ST PGP-ST		PA = 20° or 14.5° hao = 1.35m or 1.25m So = tn/2 - (2 X FA) D+F = 2.35m or 2.25m ho = 2.6m r = 0.3m FA = As per chart or as per requirement.
		ROUGHING	RGH		PA = 20° or 14.5° hao = 1.25m So = tn/2 - (2 X FA) D+F = 2.25m ho = 2.5m r = 0.2m - 0.39m

FINISHING STOCK

Module Tooth profile		Above 1 Up to 1.5	Above 1.5 Up to 2.5	Above 2.5 Up to 4.0	Above 4.0 Up to 6.3	Above 6.3 Up to 10	Above 10 Up to 12	Above 12 Up to 6	Above 16 Up to 26
ΔS	Roughing					0.5	0.8	1.0	1.2
	Pre-Shaving	0.02	0.03	0.05	0.08				
	Pre-Grinding	0.12	0.15	0.18	0.20	0.26	0.40		0.6

ADDENDUM MODIFICATION COEFFICIENT AND AMOUNT OF CHAMFER





PRESSING TOOL (HOB) INTO GROVE WHEN CUTTING GEAR

CONVERSION TABLE FOR ADDING OR SUBTRACTING THICKNESS OF TOOTH WHEN CUTTING GEAR

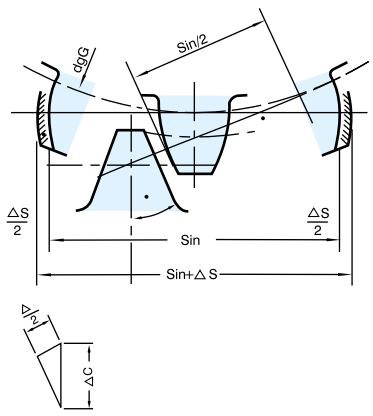
Input Value α=20°

S	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0		0.015	0.025	0.044	0.059	0.073	0.088	0.102	0.117	0.132
0.1	0.146	0.161	0.175	0.190	0.205	0.219	0.234	0.249	0.263	0.278
0.2	0.292	0.307	0.322	0.336	0.351	0.366	0.330	0.395	0.409	0.242
0.3	0.439	0.453	0.468	0.483	0.497	0.512	0.526	0.541	0.556	0.570
0.4	0.585	0.599	0.614	0.629	0.643	0.658	0.673	0.687	0.702	0.716
0.5	0.731	0.746	0.760	0.775	0.790	0.804	0.819	0.883	0.848	0.863
0.6	0.899	0.892	0.906	0921	0.936	0.950	0.965	0.980	0.994	1.009
0.7	1.023	1.038	1.053	1.067	1.082	1.097	1.111	1.126	1.140	1.155
0.8	1.170	1.184	1.199	1.214	1.228	1.243	1.257	1.272	1.287	1.301

Input Value a=14.5°

S	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0		0.020	0.040	0.060	0.080	0.100	0.120	0.140	0.160	0.180
0.1	0.200	0.220	0.240	0.260	0.280	0.300	0.320	0.340	0.360	0.379
0.2	0.399	0.419	0.439	0.459	0.497	0.499	0.519	0.539	0.559	0.579
0.3	0.599	0.619	0.639	0.659	0.679	0.699	0.719	0.739	0.759	0.779
0.4	0.779	0.819	0.839	0.859	0.879	0.899	0.919	0.939	0.959	0.979
0.5	0.999	1.019	1.038	1.058	1.078	1.098	1.118	1.138	1.158	1.178
0.6	1.198	1.218	1.238	1.258	1.278	1.298	1.318	1.338	1.358	1.378
0.7	1.398	1.418	1.438	1.458	1.478	1.498	1.518	1.538	1.558	1.578
0.8	1.598	1.618	1.638	1.658	1.677	1.697	1.717	1.737	1.757	1.777

When cutting gear, if the thickness of tooth to be laid across is as much larger as Δs than that of drawing, then press the tool (HOB shaving cutter or grindstone) into the direction toward radius as much as Δc.



TIMING BELT PROFILE

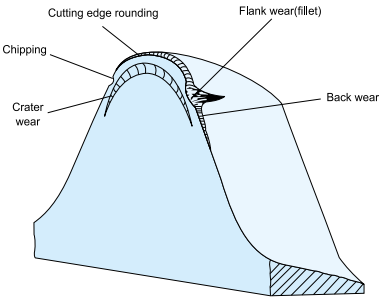
CUTTING PARAMETERES (STANDARIZED CONDITION OF MODULE 2-2.5)

Item	Range of Use			
	Subject Material to be machined	Cutting Speed [m/min]	Climb Cui Feed [mm/rv]	
			Number of Conditions 1-2	Number of Conditions 3-5
Cutting Speed and UP Milling	More than S45C	40-70	1.5 - 2.5	1.0 - 2.0
	SCM440	50-80	2.0 - 3.0	1.5 - 2.5
	SCM420 Scr420	60-110	2.5 - 3.5	2.0 - 3.0
	FID 70	40-50	2.0 - 3.0	1.5 - 2.5
Conventional cut	Asil causes to bring an damage on Hob rapidly, please avoid This job as much as possible. (Applying to alarge module)			
Work Speed	Hab RPM : Q Number of Conditions of Hab: Work Speed as=TH x (min-1) Work Dimension: Z			
Depth of Grinding	This will be depended upon all requirements of the subject gear that will machined.			
Amount of Shift	0.1m - 0.5m (m: module)			

TOOL WEAR

Damages of cutter caused by hob cutting can largely be divided into flank wear and crater wear depending upon the damaged part. Economical timing for Sharpening job will be:

- When the wear has reached up to the point of 0.2 mm from the width of frank wear.
- When the wear has reached up to the point of 0.1 mm from the depth craterwear.
- We recommend the amount of sharpening, as of (amount of wear +0.1 mm).
- And it is important to choose a grinding wheel that has been Sharp, and at the same time you need to be careful about heat that makes the edge of hob cutter duli, and occurrence of cracks during grinding works.



Types of wear on a hob tooth

Particularly, we suggest that you avoid creep feed grinding with powder metal involving with high-alloy steel, instead we commend you to do it by light cutting and grinding with high transmitting speed.

FOR EXAMPLE; S-31, SNC-30

Material of Hob	Diameter of Grinding Wheel	Number of Revolutions of Grinding Wheel	Transmitting Speed	Amount of Cutting		Grinding Liquid
HSS	200mm	2200-3000/min	300-600/min	Rough	0.10-0.15mm	Liquid exclusively for grinding purpose
				Completion	0.02-0.05mm	
Powder metal	200mm	2200-3000/min	300-600/min	Rough	0.05-0.10mm	
				Completion	0.01-0.02mm	

POINT OF SHARPENING

- To decide an economical timing for sharpening, please regard it as standard when the wear has been approached to the point of about 0.2 mm from the width of wear of clearance space.
- Be careful about occurrence of plastic deformation during grinding-works.
- Please sharpen the edge of cutter often using white stone.
- Please change grinding fluid regularly, two times a year.

Grinding Wheel now in use	CB 100-R 100B90T
Abrasive Grain	CBN (Retinoid)
Particle intensity	100
Concentration	100
Coherence	R

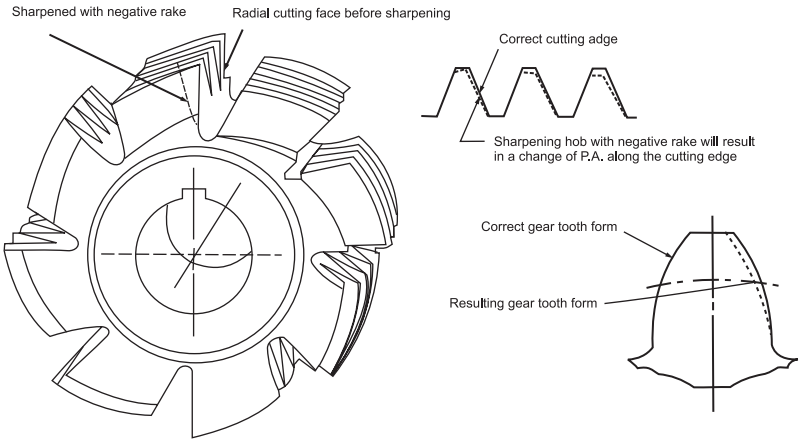
EFFECT OF SHARPENING ERRORS

Hobs resharpened on an arbor in resharpening machine that runs eccentrically will result in sharpening errors that give the same 11wandering 11profile characteristic to an involute profile as an eccentrically mounted properly sharpened hob in a hobbing machine. Other sharpening errors to the base rack that effect hob profile are:

- Hob cutting faces are sharpened with negative rake.
- Hob cutting faces are sharpened with positive rake.
- Hob cutting faces are sharpened by unequal amounts resulting in uneven flute spacing.

A hob sharpened with incorrect lead will result in one end of the hob being larger in diameter than the other. As the hob is shifted across its usable life in the hobbing machine, a change in the size of the work piece will be evident.

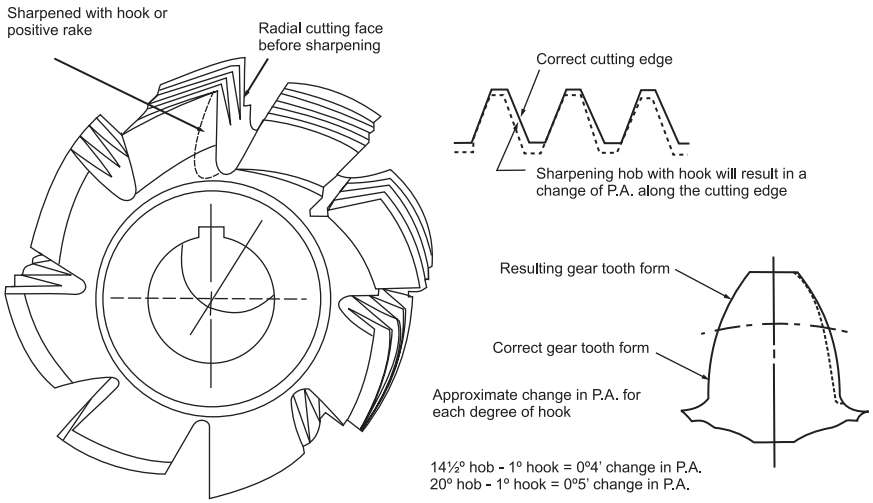
EFFECT ON PROFILE OF A HOB RESHARPENED WITH NEGATIVE RAKE



Approximate change in P.A. for each degree of drag.

14½° hob - 1° drag = 0°4' change in P.A.
20° hob - 1° drag = 0°5' change in P.A.

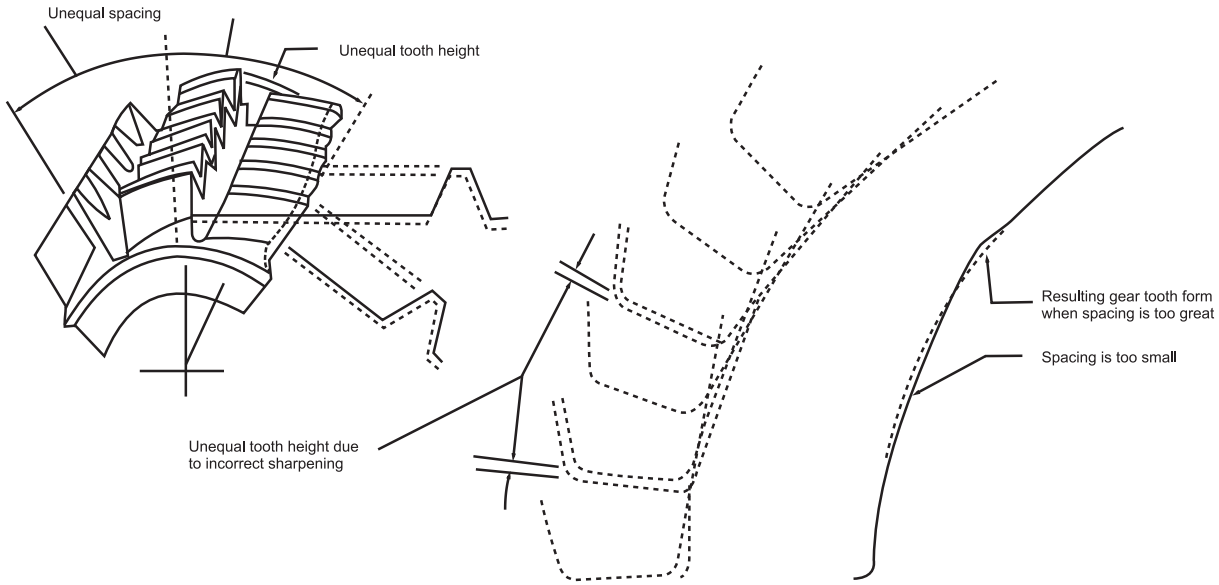
EFFECT ON PROFILE OF A HOB RESHARPENED WITH POSITIVE RAKE



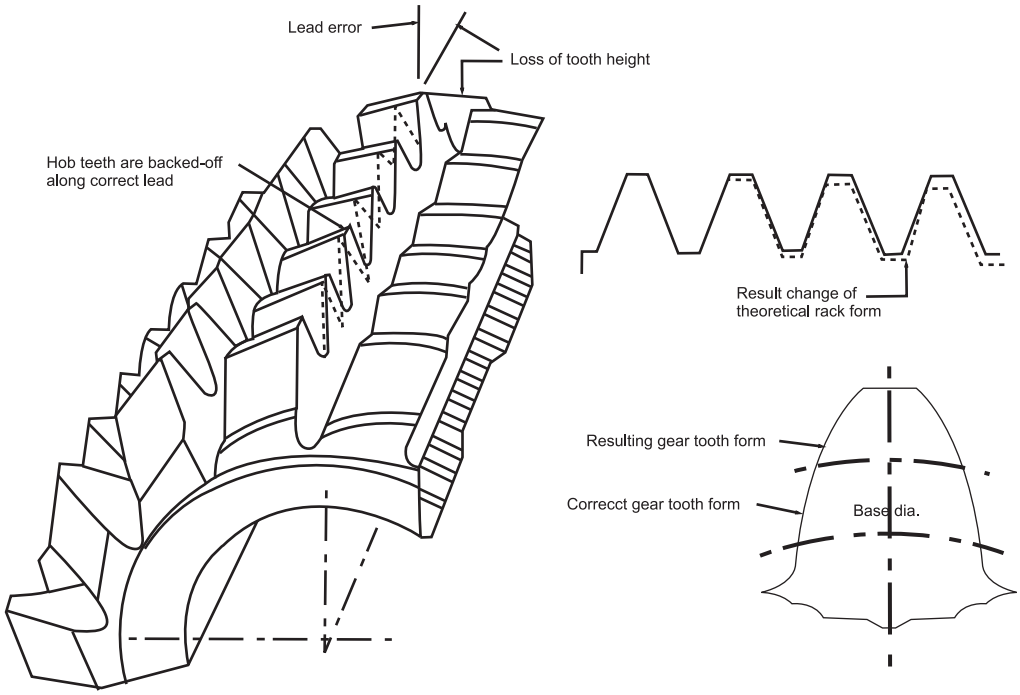
14½° hob - 1° hook = 0°4' change in P.A.
20° hob - 1° hook = 0°5' change in P.A.

EFFECT OF SHARPENING ERRORS

EFFECT ON PROFILE OF A HOB RESHARPENED WITH CUTTING FACES UNEQUALLY SPACED, CREATING ACCUMULATED FLUTE SPACING ERROR.



EFFECT ON SIZE OF WORK PIECE WHEN HOB IS RESHARPENED WITH THE INCORRECT LEAD. THE LOSS OF TOOTH HEIGHT FROM ONE END OF THE HOB TO THE OTHER RESULTS IN A CHANGE OF SIZE ON THE WORK PIECE AS THE HOB IS SHIFTED ACROSS ITS USABLE LIFE.

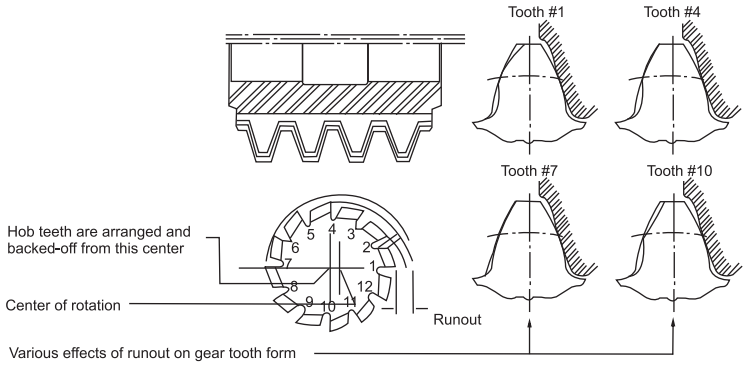


THE EFFECT OF HOB MOUNTING ERRORS

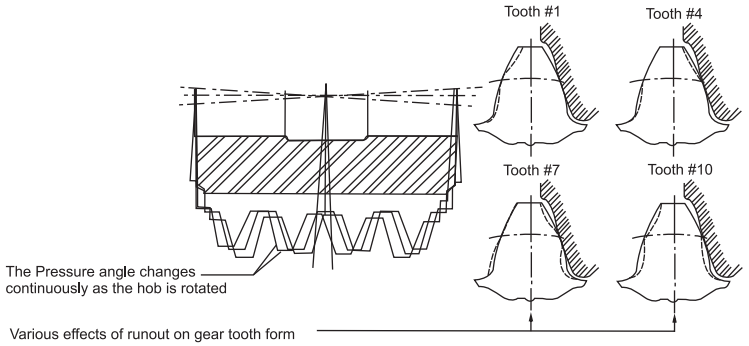
Despite hypothetically perfect hob, manufactured error free, the hob can produce profile errors if mounted eccentrically on the hobbing machine arbor. Hob runout error due to either careless mounting or to improper resharpening is the greatest contributor to out-of-tolerance hobbed involute profiles. Figures 1,2, & 3 illustrate the effects three types of hob runout have upon the gear tooth form. These effects are created, most often, by:

- Failure to true up the hob arbor.
- Failure to true up the hob on the hob arbor by truing the hub indicating bands.
- Bent, oversize or undersize hob arbor.
- Non-parallel hob clamping spacers, misaligned or wornout arbor support bearing.

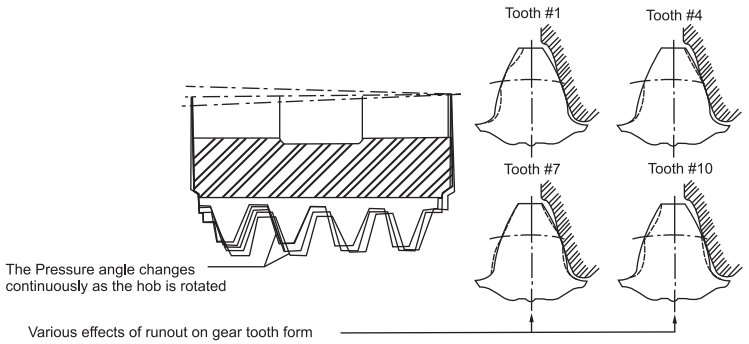
THE EFFECT OF UNIFORM RUNOUT OVER THE ENTIRE HOB.



THE EFFECT OF RUNOUT ON EACH SIDE OF THE HOB 180° APART.



THE EFFECT OF HOB RUNOUT ON ONE SIDE OF THE HOB ONLY.



HOBS

HOBS FOR SPUR & HELICAL GEARS AND INVOLUTE SPLINES

GEAR DATA

- Normal module/OP
- No. ofteeth
- Normal pressure angle
- Helix angle and hand
- Outside diameter
- Root diameter
- Amount of tip chamfer- lf applicable
- Root-fiat/full fillet
- Tip relief details- lf applicable
- DOP or MOT sizes at hobbing and finishing stage
- Material and hardness at hobbing stage

HOB DATA

- Overall size - OD x Length x Bore
- No. of starts
- Hand ofthreads
- Type - Finishing/preshave/pregrinding/roughing
- Type of profile - Nontopping/semitopping/full topping
- Class of accuracy
- Amount of shaving/grinding allowance wherever applicable

HOBS FOR STRAIGHT SPLINES

SPLINE DATA

- No. of splines
- Spline width
- Out side dia.
- Root dia.
- Form dia.
- Amount of chamfer- for semitopping hobs
- Under-cut details, if required
- Shoulder details, if applicable
- Basic profile reference standard
- Materiał & its hardness at hobbing stage

HOB DATA

- Overall size- OD x Length x Bore
- No. of starts
- Hand ofthreads
- Type of hob - Finishing/ pre-grinding
- Type of profile- Semitop/nontop/ with lugs, with shoulder etc.
- Amount of grinding allowance wherever applicable

WORM WHEEL HOBS

Since these must be tailored to the respective gears & applications, worm wheel hobs can not be manufactured in standard sizes. Therefore following details will be required:

- Drawing / details indicating worm thread & wheel tooth particulars, center distance, ratio etc.
- The type of worm thread profile ZN, ZA, ZK or Zł according to DIN 3975 or other special profile.
- The amount of assembly backlash &type of contact pattern required.
- In case of shank type hob, shank holding dimensions to suit the hobbing machine will be required.

SPROCKET HOBS

SPROCKET DATA

- Chain pitch
- Rollerdia
- Chain/ Sprocket reference standard
- Component drawing/details

HOBDATA

- Overall size- OD x Length x Bore
- No. of starts
- Hand ofthread
- Ground/unground profile

For special hobs having non standard profiles, fixed position type etc., component drawing indicating tooth profile details will be required. Hob size & profile details can be designed depending upon part requirements and suitable hob will be manufactured.

SPLINE GAUGES

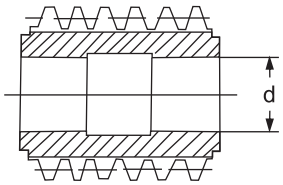
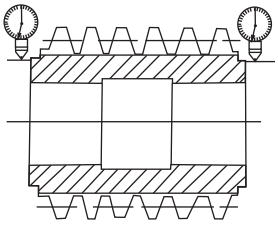
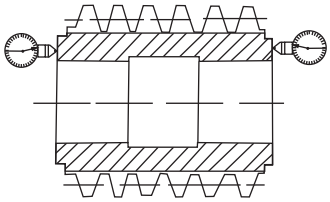
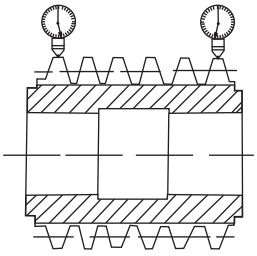
COMPONENT DATA REQUIRED FOR DESIGN OF SPLINE GAUGES

Sr. No.		PLUG GAUGES			RING GAUGES		
		Involute Serration	StSpline	Serration	Involute Serration	StSpline	Serration
1	No. ofT eeth	✓	✓	✓	✓	✓	✓
2	Module/OP	✓			✓		
3	Pressure Angle	✓			✓		
4	Spline Width/Gap		✓			✓	
5	Flank Angle Internal/Extemal			✓			✓
6	Minor Dia with Tolerance	✓	✓	✓	✓	✓	✓
7	Major Dia with Tolerance	✓	✓	✓	✓	✓	✓
8	Chamfer/Radiusat major diameter	✓	✓	✓	✓	✓	✓
9	Chamfer/Radiusat minor diameter	✓	✓		✓	✓	
10	Length of Splines	✓	✓	✓	✓	✓	✓
11	Form Diameter	✓		✓	✓		✓
12	DOP/DBP with Pin Dia.	✓		✓			
13	Max. Major Dia. of mating part	✓			✓		✓
14	Min. Minor Dia. of mating part			✓	✓		✓
15	Circular space/tooth width at PCD	✓		✓	✓		✓
16	Minor/Major Apex. Diameterwith Tolerance			✓			✓

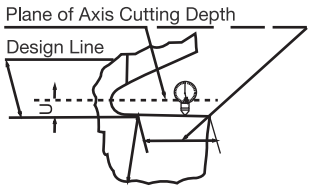
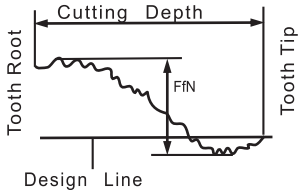
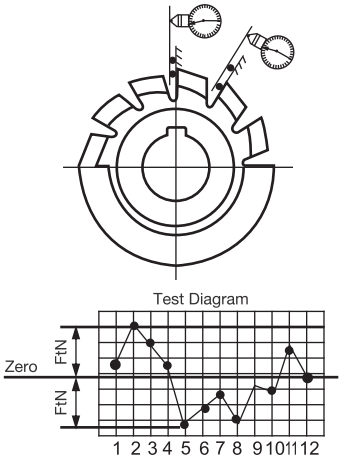
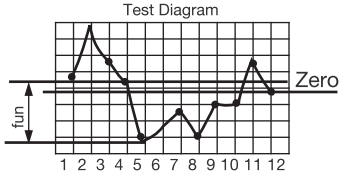
IN ADDITION CUSTOMERS TO INDICATE FOLLOWING GAUGE REQUIRED FOR CHECKING

	Yes/No
Flank	Y/N
Flank & Major Dia.	YIN
Only MajorDia.	YIN

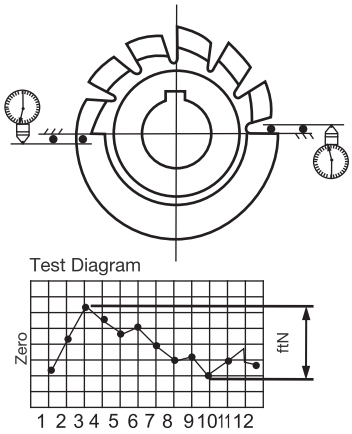
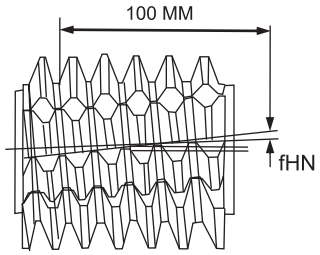
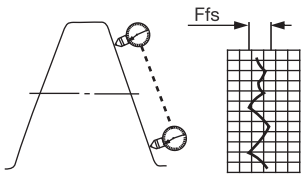
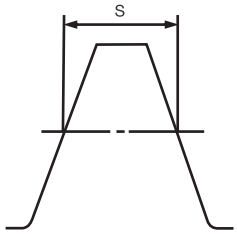
TOLERANCES AS PER DIN 3968 (IN MICRONS)

No	Measured Quantity	Symbol Denoting Variation	Class	Over 0.63 To 1	Over 1 To 1.6	Over 1.6 To 2.5	Over 2.5 To 4	Over 4 To 6.3	Over 6.3 To 10	Over 10 To 16	Over 16 To 25	Over 25 To 40
1	Bore Diameter 		A	I. S. A. Tolerance Field H5								
			B	I. S. A. Tolerance Field H6								
			C	I. S. A. Tolerance Field H5								
			D	I. S. A. Tolerance Field H7								
			AA	I. S. A. Tolerance Field H5								
2	2 Form Tolerance of Bore			1 /2 The Bore Tolerance								
3	Tolerance for Longitudinal of Clutch Drive Keyway.			According To DIN 138								
4	Radial Run-out on Bath Proof Flanges. Referenced to Bore Axis. 	frp	A	5	5	5	6	8	10	12	16	20
			B	6	6	6	8	10	12	16	20	25
			C	10	10	10	12	16	20	25	32	40
			D									
			AA	5	5	5	5	5	5	6	6	8
				The Highest Points Measured On The Two Proof Flanges Must Not Be More Than 90° Apart.								
5	Axial Run-out on Hub Face Referenced to Bore Axis 	fps	A	3	3	3	5	5	8	8	10	10
			B	4	4	4	6	6	10	10	12	12
			C	6	6	6	10	10	16	16	20	20
			D	10	10	10	16	16	25	25	32	32
			AA	3	3	3	3	3	4	5	5	6
6	Radial Run-out on Tooth Tips Referenced to Bore Axis 	frk	A	12	16	20	25	31	40	50	63	80
			B	25	32	40	50	63	80	100	125	160
			C	50	63	80	100	125	160	200	250	315
			D	100	125	160	200	250	315	400	500	630
			AA	10	10	12	16	20	25	32	40	50

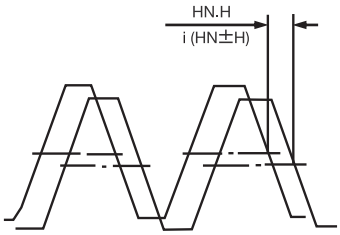
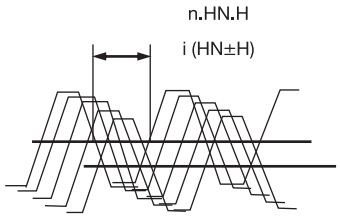
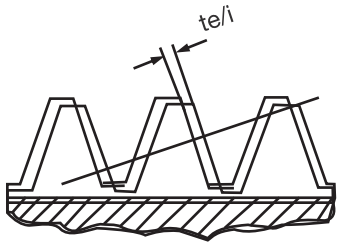
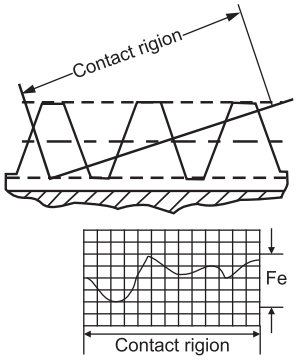
TOLERANCES AS PER DIN 3968 (IN MICRONS)

No	Measured Quantity	Symbol Denoting Variation	Class	Over 0.63 To 1	Over 1 To 1.6	Over 1.6 To 2.5	Over 2.5 To 4	Over 4 To 6.3	Over 6.3 To 10	Over 10 To 16	Over 16 To 25	Over 25 To 40
7	Form & Positional Variationof Cutting Faces  Distance u is Amount by Which Design Line is Distant Form Piane of Hab Axis (Zero, When RakeAngle is 0°) 	FfN	A	12	16	20	25	32	40	50	63	80
			B	25	32	40	50	63	80	100	125	160
			C	50	63	80	100	125	160	200	250	315
			D	100	125	160	200	250	315	400	500	630
			AA	10	10	12	16	20	25	32	40	50
8	Individual Pitch measured at Half the Tooth Height 	FtN	A	±12	±16	±20	±25	±32	±40	±50	±63	±80
			B	±25	±32	±40	±50	±63	±80	±100	±125	±160
			C	±50	±63	±80	±100	±125	±160	±200	±250	±315
			D	±100	±125	±160	±200	±250	±315	±400	±500	±630
			AA	±10	±10	±12	±16	±20	±25	±32	±32	±50
9	Tooth to Tooth Pitch Measured at Half Tooth Height 	fun	A	12	16	20	25	32	40	50	63	80
			B	25	32	40	50	63	80	100	125	160
			C	50	63	80	100	125	160	200	250	315
			D	100	125	160	200	250	315	400	500	630
			AA	10	10	12	16	20	25	32	40	50

TOLERANCES AS PER DIN 3968 (IN MICRONS)

No	Measured Quantity	Symbol Denoting Variation	Class	Over 0.63 To 1	Over 1 To 1.6	Over 1.6 To 2.5	Over 2.5 To 4	Over 4 To 6.3	Over 6.3 To 10	Over 10 To 16	Over 16 To 25	Over 25 To 40
10	Cumulative Pitch Measured at Half Tooth Height 	ftN	A	25	32	40	50	63	80	100	125	160
			B	50	63	80	100	125	160	200	250	315
			C	100	125	160	200	250	315	400	500	630
			D	200	250	315	400	500	630	800	1000	1250
			AA	20	20	25	32	40	50	63	80	100
			The Tolerances Are Referenced To The Pitch Error That Is To Say To The Largest Cumulative Pitch Error Measured On The Hab Tested.									
11	Gash Lead over 1OOMM Hab Length, Referred to Ref. Cylinder 	fHN	A	±70								
			B	±100								
			C	±140								
			D	±200								
			AA	±50								
12	Form Error Of Cutting Edge 	Ffs	A	10	11	12	14	16	20	25	32	40
			B	20	22	25	28	32	40	50	63	80
			C	40	45	50	56	63	80	100	125	160
			D									
			AA	6	6	6	8	10	12	14	18	22
13	Tooth Thickness on Reference Cylinder 	fs	A	-25	-28	-32	-36	-40	-50	-63	-80	-100
			B	-50	-56	-63	-71	-80	-100	-125	-160	-200
			C	-100	-112	-125	-140	-160	-200	-250	-320	-400
			D	-100	-112	-125	-140	-160	-200	-250	-320	-400
			AA	-16	-16	-16	-20	-25	-32	-40	-50	-63

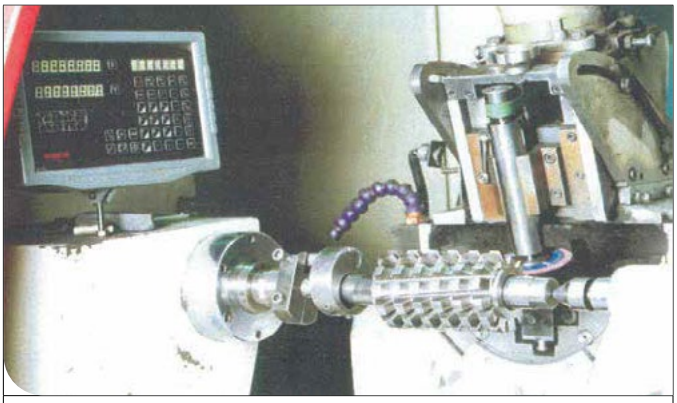
TOLERANCES AS PER DIN 3968 (IN MICRONS)

No	Measured Quantity	Symbol Denoting Variation	Class	Over 0.63 To 1	Over 1 To 1.6	Over 1.6 To 2.5	Over 2.5 To 4	Over 4 To 6.3	Over 6.3 To 10	Over 10 To 16	Over 16 To 25	Over 25 To 40
14	Hob Lead from cutting Edge to cutting Edge in the Direction of Hand 	fHF	A	±6	±7	±8	±9	±10	±12	±32	±20	±25
			B	±12	±14	±16	±18	±20	±25	±32	±40	±50
			C	±25	±28	±32	±36	±40	±50	±63	±80	±100
			D	±50	±56	±63	±71	±80	±100	±125	±160	±200
			AA	±4	±4	±4	±5	±6	±8	±10	±12	±16
			Where, HN - Lead Of Gashes Or Tooth Rows . H - Hob Lead (Helix), i-No. Of Gashes Or Tooth Rows, The Sign In The Brackets Is + IfThe Gash Lead & The Hob Lead Are In Opposite Direction & - If They Are In the Same Direction.									
15	Hob lead in the direction of hand between any two cutting edges on the same thread 	FHF	A	10	11	12	14	16	20	25	32	40
			B	20	22	25	28	32	40	50	63	80
			C	40	45	50	56	63	80	100	125	160
			D	80	90	100	112	125	160	200	250	320
			AA	6	6	6	8	10	12	14	18	22
			Where, HN - Lead Of Gashes Or Tooth Rows. H - Hob Lead (Helix), i-No. Of Gashes Or Tooth Rows, n - No. of cutting edges over which the measurement is made. The Sign In The Brackets is +ve if The Gash Lead & Hob Lead Are In Opposite Direction & - ve if they are in Same Direction.									
16	Base pitch element Measured from cutting edge to cutting edge 	fe	A	±6	±7	±8	±9	±10	±12	±16	±20	±25
			B	±12	±14	±16	±18	±20	±25	±32	±40	±50
			C	±25	±28	±32	±36	±40	±50	±63	±80	±100
			D									
			AA	±4	±4	±4	±5	±6	±8	±10	±12	±16
17	Base pitch element within a Contact region 	Fe	A	12	14	16	18	20	25	32	40	50
			B	25	28	32	26	40	50	63	80	100
			C	50	56	63	71	80	100	125	160	200
			D									
			AA	8	8	8	10	12	16	20	25	32

MANUFACTURING AND TESTING FACILITIES

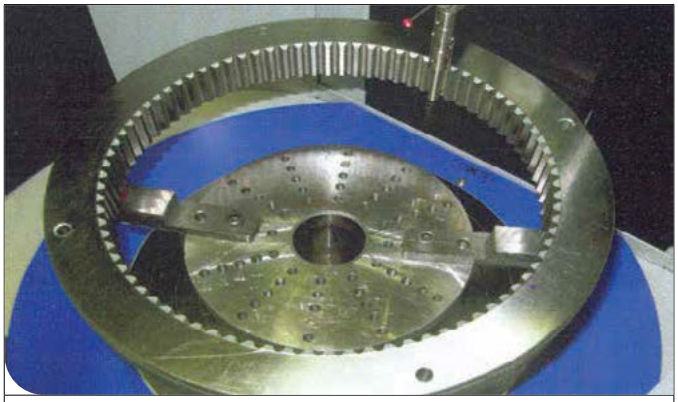
6 axis relief grinding machine

CNC relieving lathe



CNC hob sharpening

Hob inspection



Spline ring gage inspecion

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