A Study of Gear Standards and Suggested Standard Replacement Parameter for Bevel Gear

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Abstract:

Currently, two standard gear systems are available in the international market, namely, English (also called American) and Metric. Surprisingly, although the two standard systems are almost identical except using different units of measurement, yet they are not interchangeable! It could be said that gear standards lack standardization. . Meaningless terminology parameters have been replaced with meaningful terms for Bevel gear. It is recommended to use the single angular pitch as an appropriate equivalence rather than defining a linear pitch on multiple circles (circular pitch, base pitch, addendum pitch, or ded and um pitch).The "single angular pitch" term can be used as an appropriate equivalent term for the above traditional terms.

Introduction:

Gears are universally used to transmit power and rotational motion from one shaft to another in almost all types of machinery.. Nowadays, many gear standards societies, organization, associations, and/or institutes are present some of them are: the International Standards Organization(ISO), The American gear Manufacturers Association (AGMA), The American National Standards Institute (ANSI), For British(BGMA),and the Japanese (JGMA). Interchangeability of gears from different systems is still difficult. It is possible to say that "gear standards needs standardization" The main objective to improve Interchangeability between gears. The first system (ISO) namely Metric, gear module which is measured in

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millimeters, The second namely English identifies with diametral pitch expressed in unit of $inch^{-1}$.between them the Interchangeability is still difficult. In the past, and till now, the technical parameters terminology has been defining in a circle term as "pitch circle, base circle, etc, whilst, it is more convenient to use the parameter terminology according to the gear type. It is not convenient to use "circle" term for bevel gear because the latter needs conical, not circle terms to describe it.

Classification of association And Institute:

International Organization for Standardization (ISO) Officially began operations on February 23, 1947. The main objective of ISO is "to facilitate the international coordination and unification of industrial standards". We focus here on ISO technical committee for power transmission gearing (ISO TC60), the primary goal of it is to ensure that gear standards are created, kept up to date with changing technologies, reflect the needs of the industries concerned, and give assurance to the end users that gear products are durable and safe.

American Gear Manufacturers Association (AGMA):

AGMA was founded by nine U.S. gear companies in 1916. The initial membership of AGMA consisted of nine companies. The objectives of the Association which were: the advancement and improvement of that industry,
the collection and dissemination of statistics and information of value to its members; The standardization of gear design and manufacture and application; and The promotion of a spirit of cooperation among its members for improved production and increased application of gears.

American National Standards Institute (ANSI):

The United States uses two sets of standards headed and organized by:

American National Standards Institute (ANSI):

Occupational Safety and Health Administration (OSHA) is organized by the National Institute of Occupational Safety and Health (NIOSH).

Japan Gear Manufacturers Association (JGMA):

JGMA participates in JIMTOF (Japan International Machine and Tool Fair) as a cosponsor. JGMA also cosponsors the international power transmission expo .

British Gear Association (BGA):

The British Gear Association was formed in 1986 from the earlier British Gear Manufacturers' Association with the aim of broadening membership and encompassing both manufacturers and users of gears, gearboxes and transmission elements and providing a service for the whole mechanical power transmission industry.

Units between Metric and English:

for current English gears the module could be expressed in inches between parentheses in addition to the essential specification in millimeters. This is necessary for the transition period until all gears are specified in a single ISO standard. Where (inch = 25.4 mm)

For example m=5mm in Metric ⟶ m=5 (0.2) in English

Classification of Gears According to the Shape of the Gear Blank:

There are two categories:

Cylindrical gears (Fig.1)

Conical gears (Fig.2). Conical gears are frequently named bevel gears.

Gear

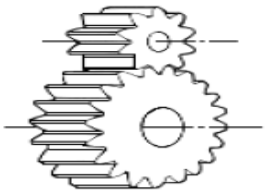


Fig.(1)
A pair of cylindrical, external, side gears with spurs teeth (spur gears).

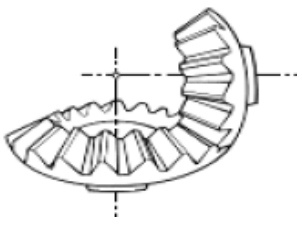


Fig.(2)
A pair of conical, or bevel gears with straight teeth (straight bevel gears)

Parameters Gear Identifying Parameters:

Table (1) [3] lists most of the terminology used in gear design and selection

Term	Metric		English	
	Symbol	Units*	Symbol	Units*
Module	*m*	Mm	-	-
Pressure angle		Deg	*Ø*	deg
Number of teeth or threads	*z*	-	*N*	-
Number of teeth, pinion	*z1*	-	*Np or n*	-
Number of teeth, gear	*z2*	-	N_G *or N*	-
Diametral pitch	-	-	P_d*or p*	in
Pi	*π*	-	*Π*	-
Pitch diameter, pinion	d_{P1}	Mm	*D*	in
Pitch diameter ,gear	d_{p2}	Mm	*D*	in
Base (circle) diameter ,pinion	d_{b1}	Mm	D_b	in
Base (circle) diameter, gear	d_{p2}	Mm	D_b	in
Circular pitch	*p*	Mm	*p*	in
Addendum	*ha*	Mm	*a*	in
Dedendum	h_f	Mm	*b*	in
Face width	*b*	Mm	*F*	in
Whole depth	*h*	Mm	h_t	in
Clearance	*c*	Mm	*c*	in
Tooth thickness	*s*	Mm	*T*	in
Center distance	*a*	Mm	*C*	in
Lead angle	*Y*	Dcg	*λ*	dcg
Helix angle	*β*	Dcg	*ψ*	dcg
Pitch base or normal	P_b*or* p_{bn}	mm	P_b *or* p_N	in
Diametral pitch normal	-	-	P_n	in
Axial pitch	*Px*	mm	*Px*	in
Root diameter, pinion	D_{f1}	mm	d_R	in
Root diameter, gear	d_{f2}	mm	D_R	in
Pitch angle, pinion	δ_1	deg	*y*	in
Pitch angle ,gear	δ_2	deg	Γ	in
Face angle, pinion	δ_{a1}	deg	*γa*	deg
Face angle, gear	δ_{a2}	deg	*Γa*	deg
Cone distance	*R*	mm	*A*	deg
Backlash	*j*	mm	*B*	deg
Throat diameter of worm	D_{t1}	mm	d_t	in
Throat diameter of worm gear	D_{t2}	mm	D_t	in

Discussion and Conclusions:

Although the gear standard systems are apparently two, they are basically the same in most aspects except the units. Therefore it is suggested to use a unified parameter to define either metric or English gears. We suggest that diametral pitch should be departed and replaced by the unified module. The unified module should be essentially expressed in units of

millimeters. For current English gears the module could be expressed in inches between parentheses in addition to the essential specification in millimeters.

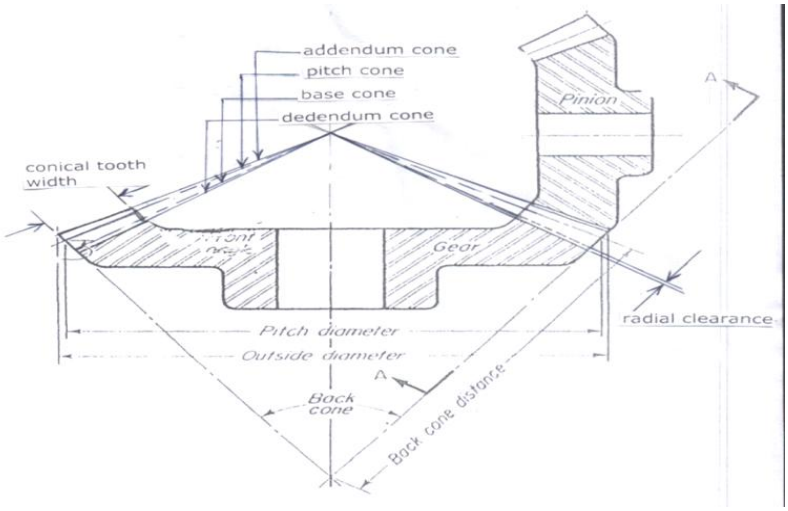
It is recommended to use a single angular pitch rather than defining a linear pitch on multiple circles (base pitch, circular pitch, addendum pitch, or dedendum pitch). Angular pitch works for all types of gears except racks and worms. The angular pitch is simply expressed as: $P_{ang} = \frac{2\pi}{z}$, rad where z is the number of gear teeth.[2]

Table(2)Shows the suggested standard Replacement parameter for the current ones

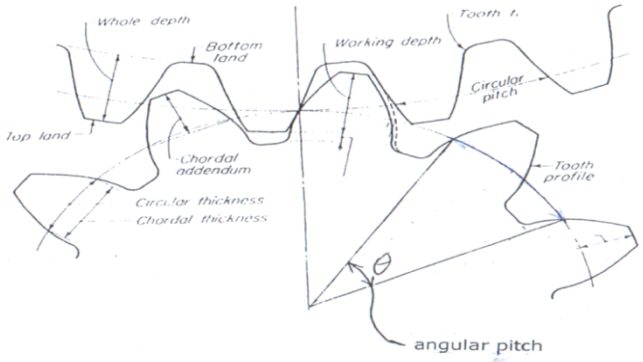
Current Conventional Gear Parameter	Suggested Standard Replacement Parameter
circular pitch	Angular pitch
base pitch	
addendum pitch	
dedendum pitch	
diametral pitch	Module, mm (supplemented with original P_d, $inch^{-1}$ between parentheses)

Table (3)Shows the differences between the Inappropriate and suggested parameters

Gear Type	Inappropriate (Meaningless)Parameter	Equivalent Parameter	Suggested Standard Measuring Parameter
Bevel gear	addendum circle	addendum cone	addendum cone
	dedendum circle	dedendum cone	dedendum cone
	pitch circle	pitch cone	pitch cone
	base circle	base cone	base cone
	face width	conical tooth width	conical tooth width
	circular pitch	angular pitch	angular pitch
	radial clearance	radial clearance	radial clearance



Suggested Standard Measuring Parameter



Bevel Gear Corrected Terminology

دراسة للمواصفات القياسية للتروس ومقترح للمصطلحات الفنية للترس المخروطي

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المستخلص:

حاليا يوجد نظامين في السوق الدولي يسمى الأول بالنظام الإنجليزي والثاني بالمتري وهما متطابقان ولكن الاختلاف في وحدات القياس ولهدا هما غير متبادلان ومن هنا يمكن القول إن نظام الوحدات القياسية الموحد يحتاج إلى التوحيد. وضع مقترح للمصطلحات الفنية الخاصة بالترس المخروطي ودلك باعتبار الزاوية الأحادية للخطوة للترس المخروطي في الترس والتي حدودها من حافة بداية السن إلى السن الأخرى تأخذ معنى كل من هده المتغيرات وهي (دائرة الخطوة, دائرة قاعدة الخطوة، المسافة بين دائرة الخطوة وقمة السن، المسافة بين دائرة الخطوة وقاع السن).

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