SAE Aerospace
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METRIC AEROSPACE STANDARD

SAE MA1696 REV. A

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Superseding MA1696

Screw Threads, Metric Buttress - MJB Profile

RATIONALE

MA1696A has been reaffirmed to comply with the SAE five-year review policy.

FOREWORD

Changes in this Revision are format/editorial only.

1. SCOPE:

This standard establishes the basic triangular profile for the MJB thread form, the design profiles, standard pitches, tolerance classes, formulae for tolerances and dimensions, tolerance tables, and a system of designations. Because of the specialized application for buttress threads, no preferred diameter-pitch series have been established for this standard and each application will require use of the thread formulae for dimensions and related tolerances given herein for deriving the thread dimensional requirements.

1.1 Purpose:

This standard specifies the characteristics of the MJB metric series of buttress screw threads based on 7°/45° form, with width of truncation same as MJ screw thread profile, and with a controlled radiused root in the external thread.

2. REFERENCES:

ANSI B1.9
ISO 965/I

3. APPLICATION:

The MJB buttress screw thread is intended for aerospace metric applications where high axial thrust loading in one direction is required with the radial component of the thrust load reduced to a minimum. Thus hoop stress, such as in thin walled parts, can be held to a minimum.

4. PROFILE OF THREAD:

4.1 Basic Profile:

The basic profile is the theoretical profile corresponding to the basic dimensions of the thread major diameter, pitch diameter and minor diameter. See Figure 1.

4.2 Basic Thread Profile Symbols:

The symbols used in the basic profile shown in Figure 1 represent the thread dimensions given in Appendix A, Symbols - MJB Thread Dimensions & Tolerances.

4.3 Design Profiles:

The design profile for the internal thread at maximum material condition is the same as the basic profile except, in practice, the root is cleared above the basic major diameter, D bsc.; see Figure 2. The design profile for the external thread at maximum material condition is the basic profile with an allowance applied and a maximum radiused root, tangential to the flanks, as shown in Figure 3.

5. THREAD PITCHES:

This standard includes the following selected thread pitches extracted from ISO 965/I:

Pitch P, mm
1.25
1.5
2
2.5
3

6. THREAD CLASSES (TOLERANCES):

6.1 Length of Thread Engagement:

The pitch diameter tolerances specified herein are based on a length of thread engagement with the GO gaging member having ten pitches. The actual thread engagement of the product threads are normally applicable for lengths of engagement up to 15 pitches. Where the length of thread engagement exceeds that for which these standard tolerances are applicable, refer to paragraph 7.4, Special Lengths of Thread Engagement, for pitch diameter tolerance increase.

6.2 Tolerance System:

The system for designating thread tolerance is based on the International Standard ISO 965/I metric screw thread system of tolerance positions and grades; however, the tolerances are derived from ANSI B1.9 formulae adapted to the metric system.

6.3 Internal Thread Class:

The internal thread class is:

Class 4H

The tolerance position H provides zero allowance. The pitch diameter tolerance TD_2 and the minor diameter tolerance TD_1 are identical, grade 4. In relation to ANSI B1.9 inch class, metric Class 4H is similar to precision inch Class 3.

6.4 External Thread Class:

The external thread class is:

Class 4d

The tolerance position d = (0.075 + 0.011P) provides a clearance allowance from basic profile for easy assembly of parts. The pitch diameter tolerance Td_2 and the major diameter tolerance Td are identical, grade 4. In relation to ASNI B1.9 inch class, the metric allowance d is similar to the inch allowance and metric Class 4d is similar to precision inch Class 3.

6.5 Direction of Tolerances:

The class tolerances are positive for internal threads and negative for external threads, that is, in the direction of the minimum material. See Figures 4 and 5.

6.6 Cumulative Form Tolerance:

The cumulative form variation is the combined effect on functional size due to individual thread form variations in lead (pitch), helix, flank angle, taper, roundness, and other form variations of the thread. The allowable amount of cumulative form variation shall be as follows:

	Cumulative Form Tolerance
Classes 4H and 4d	70% of PD Tolerance

6.7 Runout of Ext Thd Major Dia & Int Thd Minor Dia:

The runout of the external thread major diameter and internal thread minor diameter relative to their respective pitch cylinder shall be within the full indicator movement equal to the pitch diameter tolerance.

6.8 Profile Dimensions and Tolerances:

The thread profile data is given in Table 1. The profile dimensions and tolerances (T) shown in Figure 4 and 5 shall be derived from the formulae in paragraphs 6.8.1 and 6.8.2.

6.8.1 External Thread:

d bsc	= nominal major diameter
es	= allowance d = 0.075 + 0.011P (See Table 2)
d max	= d bsc - es
d min	= d max - Td, where Td - Td_2 (See Table 3)
d_2 max	= d max - 0.667982P (See Table 1)
d_2 min	= d_2 max - Td_2, where Class 4d, $Td_2(4) = 0.0109\sqrt[3]{d\ bsc} + 0.055\sqrt{P}$ (See Table 3)
d_3 max	= d_2 max - 0.574599P (See Table 1)
d_3 min	= d_2 min - 0.643068P (See Table 1)
d_3 max - d_3 min	= Td_3
R max	= 0.137P (See Table 4)
R min	= 0.107P (See Table 4)

6.8.2 Internal Thread:

D bsc	= nominal major diameter
D min	= D bsc
D_3 max	= D_2 max + 0.816423P (See Table 1)
D_2 min	= D min - 0.667982P (See Table 1)
D_2 max	= D_2 min + TD_2, where Class 4H, $TD_2(4) = 0.0109\sqrt[3]{D\ bsc} + 0.055\sqrt{P}$ (See Table 3)
D_1 min	= D min - 1.001973P (See Table 1)
D_1 max	= D_1 min + TD_1, where TD_1 = TD_2 (See Table 3)

6.8.3 Dimensions computed by using the formulae given in paragraphs 6.8.1 and 6.8.2 should be rounded to 3 decimal places per rules given in Appendix C.

6.9 Helix (Pitch) Variation:

A variation in the helical path of a buttress thread increases the functional size of an external thread and decreases the functional size of an internal thread. The formula for the change in functional size of the thread relative to a change in the axial position of the helix is as follows:

$$\Delta D_2 \text{ or } \Delta d_2 = 2\delta P / (\tan 45° + \tan 7°) = 1.781\delta P \qquad \text{(Eq. 1)}$$

where:

ΔD_2 = change in int thd functional PD
Δd_2 = change in ext thd functional PD
δP = change in axial position of helix

6.9 (Continued):

The allowable variation in helix is between any two threads not farther apart than the basic length of thread engagement, Le bsc. The helix tolerance is the total width of tolerance zone parallel to thread axis, and centered about the true helix, within which the actual helical path (positive and negative) must lie. The helix tolerance (See Table 5) is based on the following change in Functional PD:

	Helix Tolerance, $T\delta P$
Classes 4H and 4d	35% of PD Tolerance

6.10 Flank Angle Variations:

A variation in one or both of the flank angles increases the functional size of an external thread and decreases the functional size of an internal thread. The approximate formula for the change in functional size of the thread relative to changes in the flank angles is as follows:

$$\Delta D_2 \text{ or } \Delta d_2 = P(0.0075\delta\alpha_2 + 0.0158\delta\alpha_1) \quad \text{(Eq. 2)}$$

where:

ΔD_2 = change in int thd functional PD
Δd_2 = change in ext thd functional PD
$\delta\alpha_1$ = change in 45° flank angle
$\delta\alpha_2$ = change in 7° flank angle

The 7° and 45° flank angle tolerances (See Table 6) are based on the following change in functional PD:

	Flank Angle Tolerance $T\delta\alpha_1$ (45°)	$T\delta\alpha_2$(7°)
	Percentage of PD Tolerance	
Classes 4H and 4d	30%	5%

6.11 Root Radius of the Thread:

6.11.1 Internal Thread: For internal threads the profile of the actual root of the thread shall at no point be below the basic profile or above the maximum root diameter, D_3 max. No root radius is specified.

6.11.2 External Thread: For external threads the profile of the actual root of the thread shall lie within the root radius tolerance zone shown in Figure 5. The limit dimensions of the root radius R are specified in Table 7. The profile shall be a continuous smoothly blended non-reversing curve no part of which shall have a radius of less than 0.107P and the arc of which is tangential to the thread flanks at not less than 0.5625H basic thread depth. The profile may comprise tangent flank circular arcs that are joined by a tangential flat at the root, provided that the root diameter is within the zone established by the formulae in paragraph 6.8.1.

6.12 Incomplete Lead Threads:

To avoid ineffective feather edge lead threads, the incomplete lead threads between the end of the part and the first fully formed thread shall be removed to a blunt start. Not more than one complete turn of incomplete lead thread shall be removed up to where the blunt start shall begin, and the depth of material removal shall not exceed the full thread depth. See Figure 6.

6.13 Thread Runout:

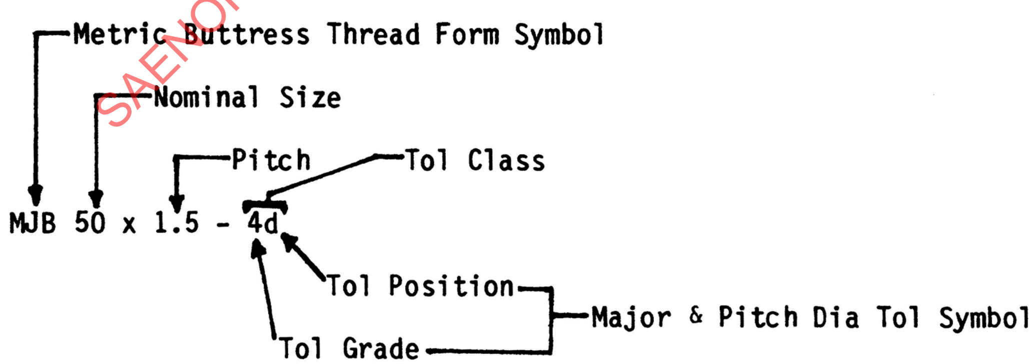
On parts without a thread undercut for thread relief, the thread runout between the start of the unthreaded portion of the part and the first full thread root shall be between two thread pitches maximum and one thread pitch minimum in length. The root of the runout threads shall join the flanks with fillets having radii not less than the minimum root radius specified for the external thread. The flanks and root of external runout threads shall be smooth and devoid of abrupt tool stop marks.

7. DESIGNATION OF THREADS:

7.1 Basic Designation:

ISO metric threads are identified by the letter "M" in the thread designation. This aerospace metric buttress screw thread is designated by the letters "MJB" to identify the metric controlled root radius, 7°/45° buttress thread form, having truncation same as the "J" screw thread form. The basic designation comprises the thread form letters "MJB" followed by the nominal size and the pitch in millimetres (separated by the sign "x"), and followed by the tolerance class (separated by a dash from the pitch). Unless otherwise specified in the designation, the buttress screw thread helix is right hand and is a tension loaded type buttress with the 45° clearance flank leading the 7° load bearing flank. For the compression loaded type buttress, with the 7° load bearing flank leading the 45° clearance flank, the letter "C" is added to the end of the designation separated by a dash (see Figure 7 for tension & compression threads). For left hand buttress screw threads, add the letters "LH" after the class, separated by a dash.

Example: External Thread, Right Hand, Tension Type:



7.1 (Continued):

Example: Internal Thread, Right Hand, Tension Type:
MJB 50 x 1.5 - 4H

Example: External Thread, Left Hand, Tension Type:
MJB 50 x 1.5 - 4d - LH

Example: External Thread, Left Hand, Compression Type:
MJB 50 x 1.5 - 4d - LH - C

7.2 Detail Drawing Specification:

Detail drawings of parts having MJB threads shall specify the following dimensions and this specification number under the basic MJB thread designation:

External Thread	Internal Thread
d min & max, major dia	D min, major dia
d_2 min & max, pitch dia	D_2 min & max, pitch dia
d_3 min & max, root dia	D_1 min & max, minor dia

An enlarged sectional view of the thread form may be used to indicate the relationship of the thread flank angles to the adjacent features, such as, undercut, end face, etc.

Example: External Thread, RH tension type

MJB 50 x 1.5 - 4d
MAJOR DIA 49.796-49.908
PITCH DIA 48.794-48.906
ROOT DIA 47.829-48.044
MA1696

Example: Internal Thread, RH tension type

MJB 50 X 1.5 - 4H
MAJOR DIA 50.000 MIN
PITCH DIA 48.998-49.110
MINOR DIA 48.497-48.609
MA1696

7.3 Designation of Multiple Start Threads:

If a multiple start thread is required, it is designated by specifying sequentially the thread form symbol, nominal size, pitch in millimetres suffixed by the letter "P" (separated by the sign "x" from the nominal size), tolerance class (separated by a dash from the pitch), lead in millimetres suffixed by the letter "L" (separated by the sign "x" from the class), and the number of starts in parenthesis.

Example: MJB 50 x 1.5P - 4c x 3L (2 STARTS)

Multiple start external threads require more clearance allowance for ease of assembly than that allowed for single start threads. In lieu of tolerance position d used for single start external threads, the following additional tolerance positions are provided for multiple start threads:

No. of Thread Starts	Tolerance Position Letter	Tolerance Position Formula
1	d	0.075 + 0.011P
2	c	0.100 + 0.011P
3	b	0.125 + 0.011P
4	a	0.150 + 0.011P

See Table 2 for values of external thread allowances (tolerance positions) for the selected standard thread pitches.

7.4 Special Lengths of Thread Engagement:

Where the length of product threads exceeds the standard engagement given in paragraph 6.1 (for which the standard tolerances are applicable), the pitch diameter tolerances should be computed from the following formula for tolerance grade 4:

$$TD_2(4) \text{ or } Td_2(4) = 0.0109\sqrt[3]{d\ bsc} + 0.009\sqrt{Le} + 0.027\sqrt{P} \qquad \text{(Eq. 3)}$$

where:

d bsc = basic major dia of external thread
Le = length of thread engagement on special G0 gage length
P = pitch of thread

The length of the special G0 gage is selected to assure engagement for the special length of thread engagement.

7.4.1 Designating Threads Having Special Lengths of Thread Engagement: Where a standard class buttress thread has a special length of engagement differing from that for which the standard pitch diameter tolerances are applicable, the thread class symbol is suffixed by the letters "SE" (special engagement & special PD tol), and the thread data shall specify the special PD limits based on the special PD tolerance derived from formula in paragraph 7.4. In addition the thread data shall include the special length of engagement, Le.

Example: Le based on 20 pitches of G0 gaging length.

MJB 50 X 1.5 - 4d SE
MAJOR DIA 49.796-49.908
PITCH DIA 48.784-48.906
ROOT DIA 47.819-48.044
ROOT RAD 0.160-0.206
HELIX TOL 0.024
Le 30

Note: Using the formula in paragraph 7.4, the special Td_2 for 20 pitches of engagement becomes 0.122 mm which results in d_2 = 48.784-48.906. Using the formula in paragraph 6.9, based on the special Td_2, the helix tolerance becomes 0.024 mm. The tolerances for flank angles are the standard values given in Table 6. The min root diameter is computed from the formula in paragraph 6.8.1 based on d_2 min = 48.784 which results in d_3 min = 47.819.

8. INSPECTION:

Inspection of the thread dimensional requirements may be performed with gages or measuring instruments (optical, mechanical, etc.) of the type commercially available. The table in Appendix B provides wire diameter sizes and constants for pitch diameter measurement.

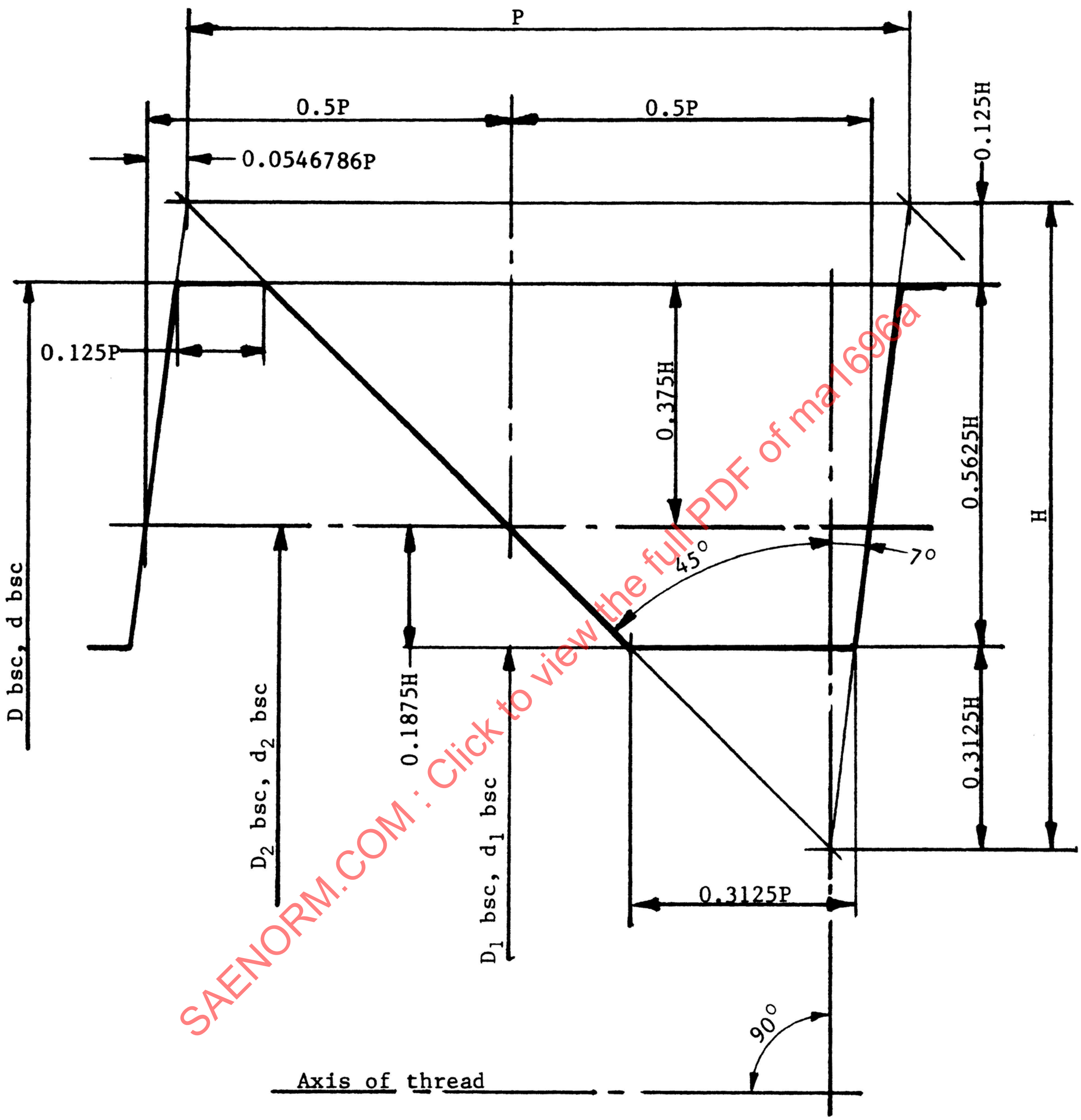


FIGURE 1 - Basic MJB Profile, Buttress Screw Thread

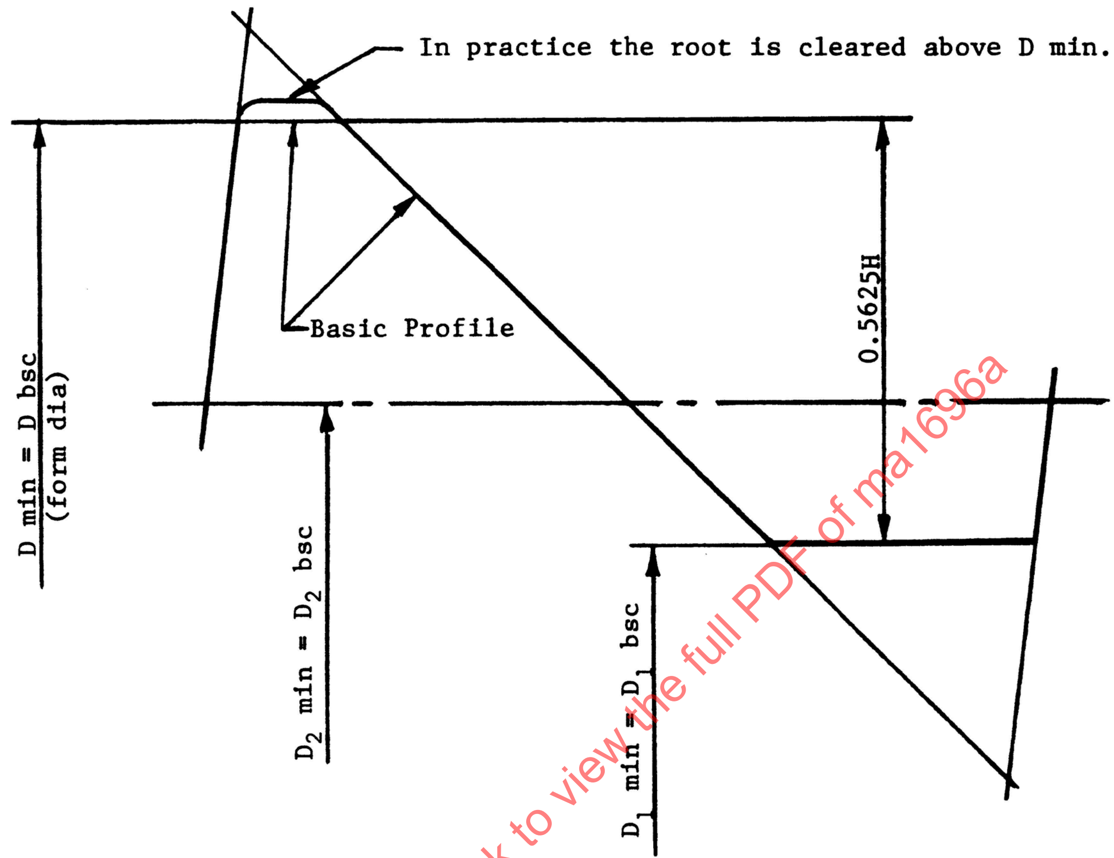


FIGURE 2 - Internal Thread Design Profile

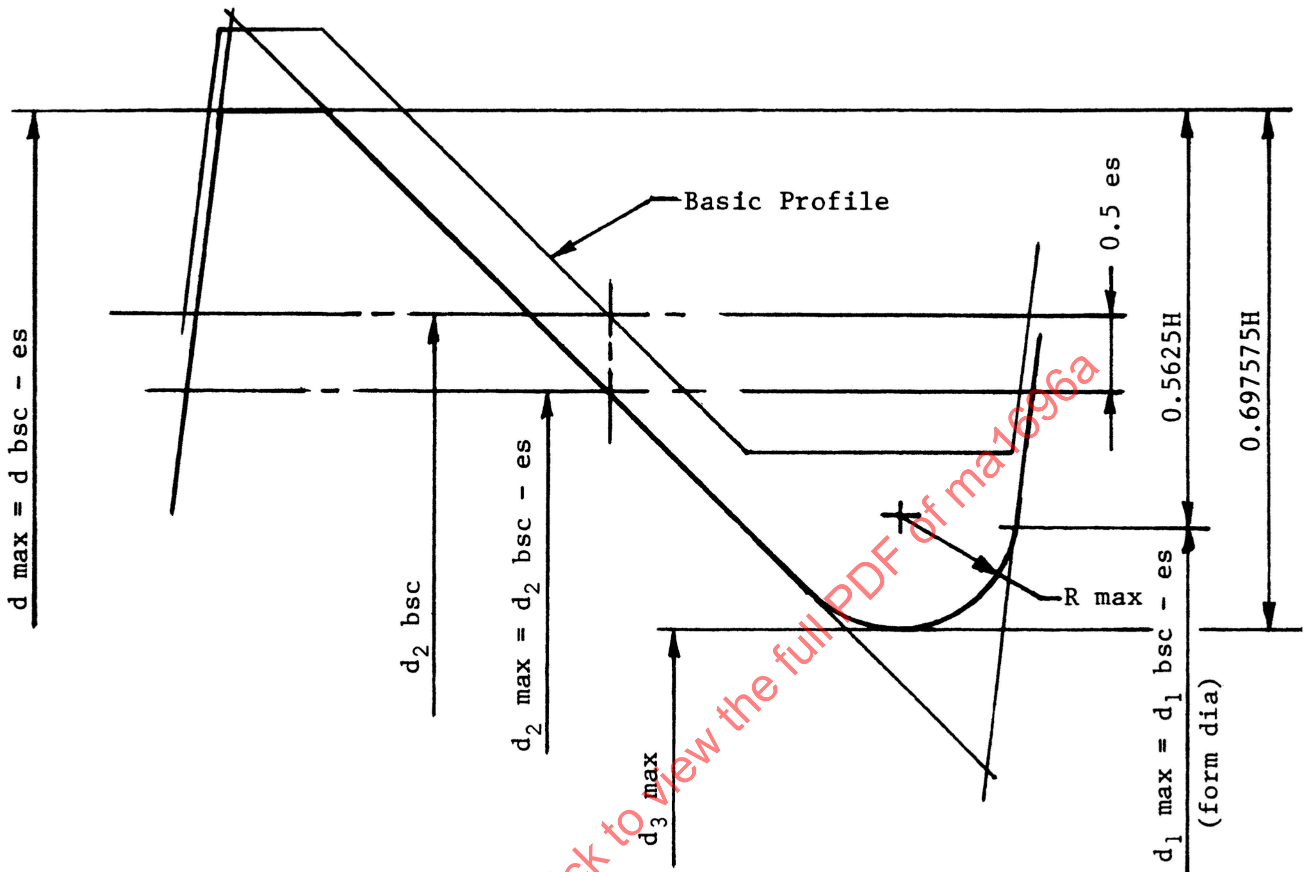


FIGURE 3 - External Thread Design Profile

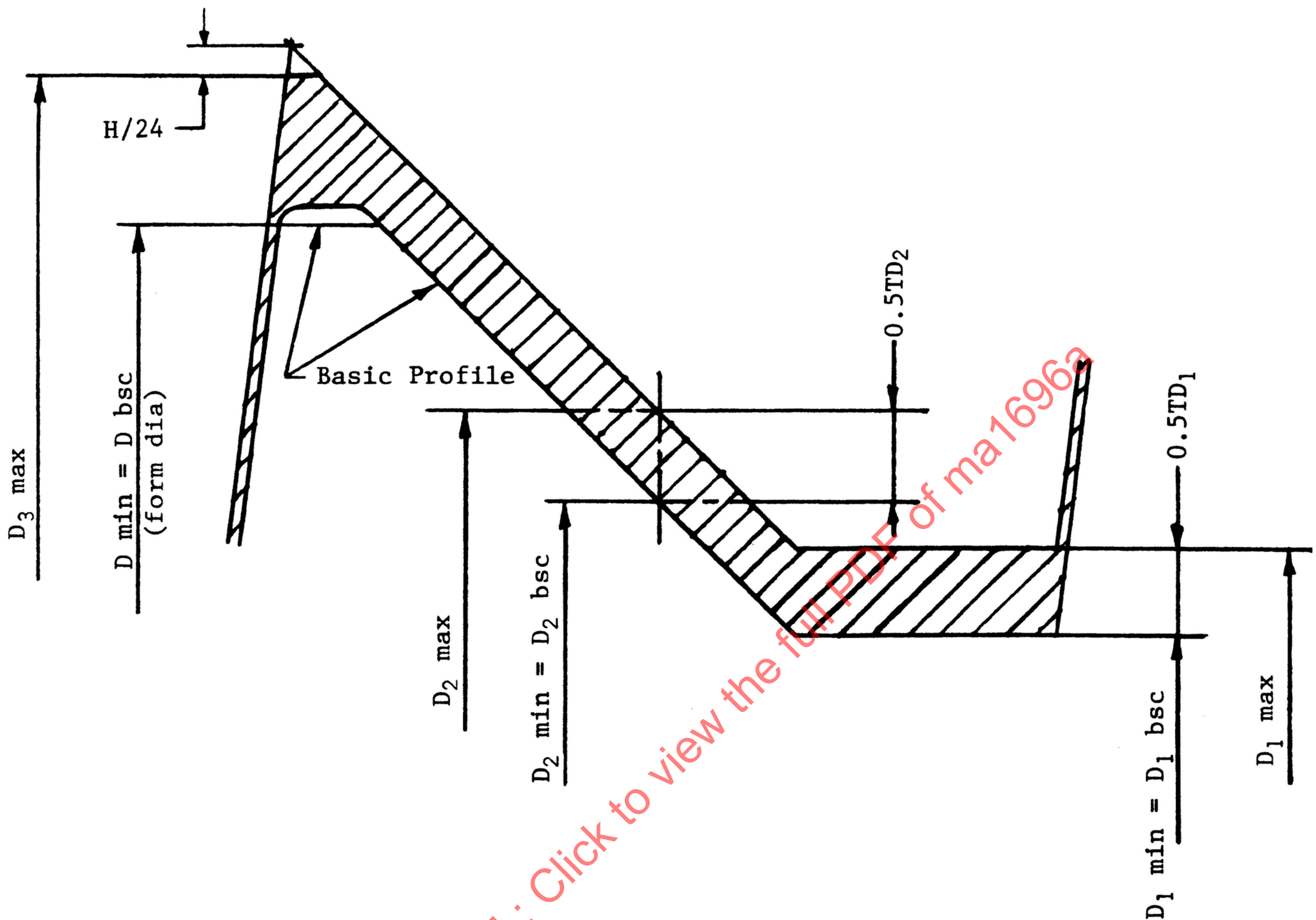


FIGURE 4 - Internal Thread Tolerances

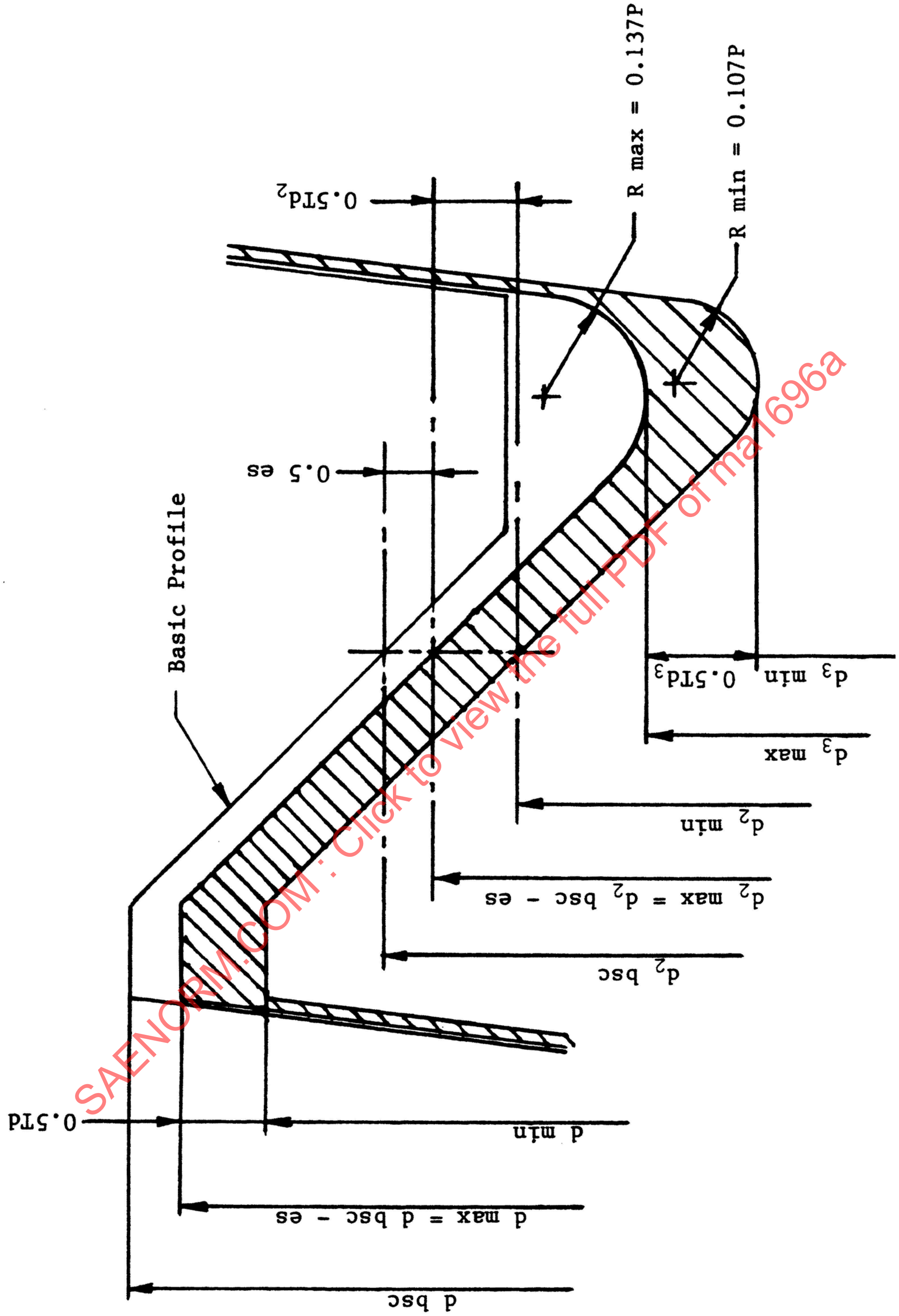


FIGURE 5 - External Thread Tolerances

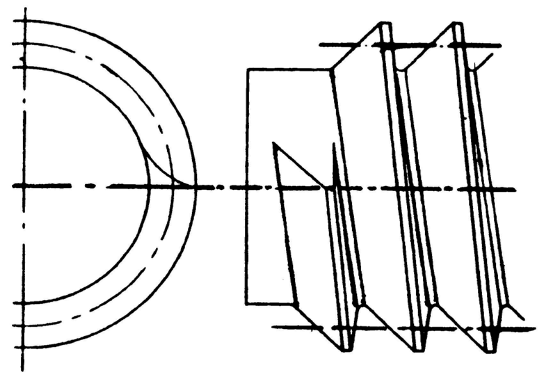
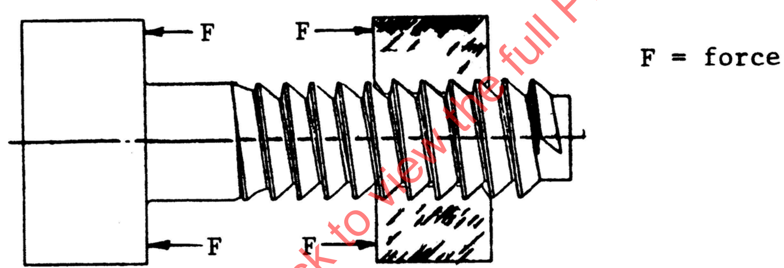
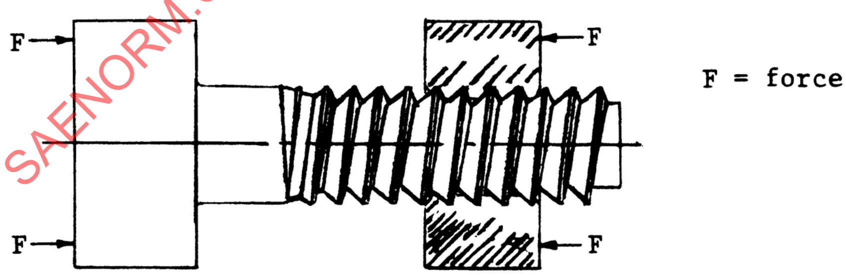


FIGURE 6 - Blunt Start Thread at Entering End



a) Tension Type Buttress Thread



b) Compression Type Buttress Thread
(left hand)

FIGURE 7 - Tension & Compression Threads

TABLE 1 - Theoretical Thread Profile Data
(Millimetres)

Pitch	H	0.125H		0.3125H		0.375H
P	0.890643P	0.111330P	0.125P	0.278326P	0.3125P	0.333991P
1.25	1.11330	0.13916	0.15625	0.34791	0.39062	0.41749
1.5	1.33596	0.16700	0.18750	0.41749	0.46875	0.50099
2	1.78129	0.22266	0.25000	0.55665	0.62500	0.66798
2.5	2.22661	0.27832	0.31250	0.69582	0.78125	0.83450
3	2.67193	0.33399	0.37500	0.83498	0.93750	1.00197
Pitch	**0.5625H**			**0.75H**	**11/12 H**	**1.125H**
P	**0.500987P**	**0.574599P**	**0.643068P**	**0.667982P**	**0.816423P**	**1.001973P**
1.25	0.62623	0.71825	0.80384	0.83498	1.02053	1.25247
1.5	0.75148	0.86190	0.96460	1.00197	1.22463	1.50296
2	1.00197	1.14920	1.28614	1.33596	1.63285	2.00395
2.5	1.25247	1.43650	1.60767	1.66996	2.04106	2.50493
3	1.50296	1.72380	1.92920	2.00395	2.44927	3.00592

TABLE 2 - External Thread Allowance
(Upper Deviation)

Amount of Reduction on d bsc and d_2 bsc
(Millimetres)

Pitch	es	es	es	es
P	d	c	b	a
1.25	0.089	0.114	0.139	0.164
1.5	0.092	0.116	0.142	0.166
2	0.097	0.122	0.147	0.172
2.5	0.102	0.128	0.152	0.178
3	0.108	0.133	0.158	0.183

TABLE 3 - Tolerances
Internal Thread Minor Diameter Tolerance, TD_1
Internal Thread Pitch Diameter Tolerance, TD_2
External Thread Major Diameter Tolerance, Td
External Thread Pitch Diameter Tolerance, Td_2
(Millimetres)

D & d		Pitch	Grade 4
over	to & incl	P	TD_1(4) TD_2(4) Td (4) Td_2(4)
11.2	22.4	1.25	0.089
		1.5	0.095
		2	0.106
		2.5	0.115
22.4	45	1.5	0.103
		2	0.113
		2.5	0.122
		3	0.130
45	90	1.5	0.112
		2	0.122
		2.5	0.131
		3	0.140
90	180	1.5	0.123
		2	0.134
		2.5	0.143
		3	0.151
180	355	2.5	0.158
		3	0.166

TABLE 4 - External Thread Root Radius, R
(Millimetres)

Pitch P	Root Radius, R min	 max
1.25	0.134	0.171
1.5	0.160	0.206
2	0.214	0.274
2.5	0.268	0.342
3	0.321	0.411