PHILIPPINE ARGRICULTURAL ENGINEERING STANDARD PAES 318: 2002
Engineering Materials – Clutches, Couplings, and Splines for Agricultural Machines – Specifications and Applications

Foreword

The formulation of this National Standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Enhancing the Implementation of AFMA Through Improved Agricultural Engineering Standards" which was funded by the Bureau of Agricultural Research (BAR) of the Department of Agriculture (DA).

This standard has been technically prepared in accordance with PNS 01-4:1998 (ISO/IEC Directives Part 3:1997) – Rules for the Structure and Drafting of International Standards. It provides specifications and proper application of clutches, couplings, and splines for agricultural machines.

The word “shall” is used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted.

The word “should” is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that certain course of action is preferred but not necessarily required.

In the preparation of this standard, the following references were considered.

Baumeister, Theodore (ed.) 1997. Mark’s handbook for mechanical engineers. 10th Edition. Mc Graw Hill Book Company, USA.

Carmichael, C. (ed.) 1950. Kent’s Mechanical engineer’s handbook. Design and production volume. 12th Edition. John Wiley and Sons, Inc., USA.

Faires, V. M. 1969. Design of Machine Elements. Macmillan Company, New York USA.

Horton, H. L. (Ed.) 1984. Machinery’s handbook. 23rd Edition. Industrial press Inc, New York.

Shigley, Joseph, E. 1977. Mechanical engineering design. 3rd Edition. Mc Graw Hill Book Company, USA.

Engineering Materials – Clutches, Couplings, and Splines for Agricultural Machines – Specifications and Applications

1 Scope

This Standard establishes specifications and provides technical information for the proper application of clutches, couplings, and splines for agricultural machinery. However, this standard does not cover clutches for four-wheel tractors.

2 Application

Couplings are used to join lengths of shafting, which must often be sectionalized for practicability and economy in manufacture and shipping or for purposes of ready installation. Clutches are couplings which permits the disengagement of the coupled shafts during rotation. Splines are used for the transmission of power from a shaft to hub or vice versa.

3 Clutches

3.1 Types

3.1.1 Friction clutches

Friction clutches are designed to reduce coupling shack by slipping during the engagement period. They also serve as safety devices by slipping when the torque exceeds their maximum rating.

3.1.1.1 Centrifugal clutch

A centrifugal clutch produces its torque by virtue of the centrifugal force of weights pressing against the driving or frictionally driven member.

3.1.1.2 Cone clutch

The conical friction clutch consists of a frustum of a cone, so fitted to a shaft by means of a feather key that it can be pushed into an opposite engaging surface rigidly attached to the other shaft.

3.1.2 Positive clutches

Positive clutches are designed to transmit torque without slip, jaw clutches are the most common. These are made with square jaws for driving in either directions, or spiral jaws for unidirectional drive. These are used for slow-moving shafts, where sudden starting action is not objectionable and where the inertia of the moving parts is relatively small.

3.2 Nomenclature of clutches

Nomenclature of clutches shall be as shown in Figures 1, 2, and 3.

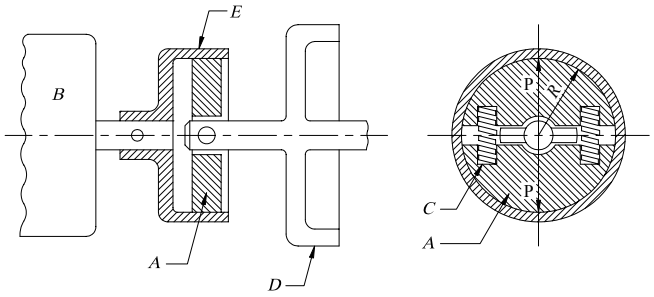


Figure 1 – Centrifugal clutch

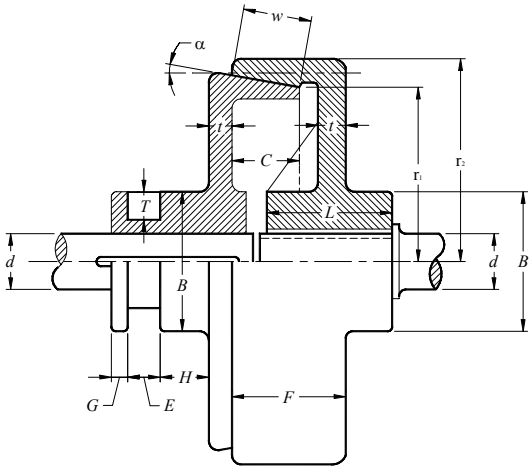
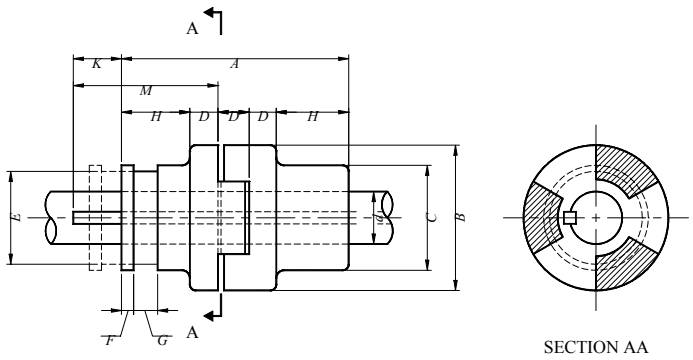
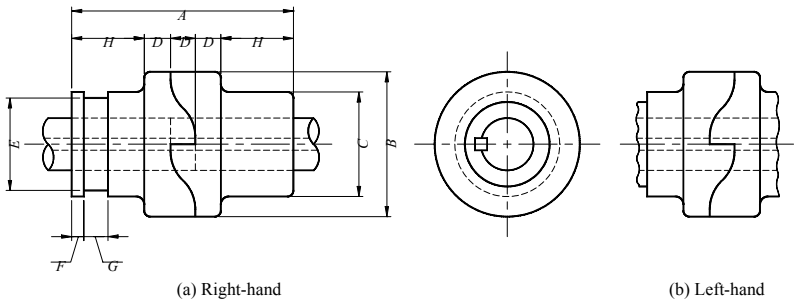


Figure 2 – Cone clutch



A. Square jaw clutch



B. Spiral jaw clutch

Figure 3 – Jaw clutches

3.3 Dimensions and ratings of clutches

Dimensions and ratings of clutches shall be as specified in Tables 1 to 3.

Table 1 – Speed (rpm) ratings of centrifugal clutches

Bore range, mm	Max. speed rpm
10 to 25	6,300
10 to 38	5,000
10 to 38	4,000
13 to 44	3,200
19 to 69	2,500
29 to 95	2,000

Table 2 – Dimensions and ratings of cone clutches

Bore, mm	Torque rating at 1750 rpm, N-m	Overall diameter, mm	Overall length, mm
13	23	70	95
16	23	70	95
25	93	116	146

Table 3 – Dimensions of square jaw clutches

Shaft diameter, mm	Dimensions, mm									
	A	B	C	D	E	F	G	H	K	M
24	121	76	51	13	41	13	6	41	19	73
30	137	89	64	16	54	13	6	44	25	86
37	159	105	76	19	64	14	10	51	29	98
43	175	121	89	22	73	14	10	54	35	111
49	191	137	102	25	83	16	10	57	38	121
56	206	152	114	29	92	16	10	60	44	133
62	222	171	127	32	105	16	11	64	48	143
68	238	181	140	35	117	17	11	67	51	152
75	254	197	152	38	130	17	13	70	57	165
87	292	210	178	44	149	19	13	79	64	187
100	318	241	203	51	171	21	16	83	73	206

4 Couplings

4.1 Types

4.1.1 Rigid couplings

Rigid couplings are used when the shafts are virtually collinear and when they remain in a fixed angular relation with respect to each other (except for angular deflection).

4.1.1.1 Clamp shaft coupling

A clamp shaft coupling is essentially a split and bolted sleeve coupling, proportioned to clamp firmly on the shafts (Fig 4).

4.1.1.2 Flange face coupling

Flange couplings are commonly used in permanent installations for heavy loads and large sizes and particularly for vertical drives, as agitators (Fig. 5).

4.1.2 Flexible couplings

Flexible couplings are designed to connect shafts which are misaligned either laterally or angularly. A secondary benefit is the absorption of impacts due to fluctuations in shaft torque or angular speed.

4.1.2.3 Gear-type coupling

The hubs have integral external gear teeth, perhaps crowned, that mesh with internal teeth in the casing through 360° as in a splined connection. Flexibility is obtained by play between the teeth (Fig. 6).

4.1.2.1 Oldham (double slider) coupling

Eliminates the need for large clearances and the resultant noisy backlash by providing a double-tongued central slider fitting between two flanges slotted at right angles to each other (Fig 7).

4.1.2.2 Rubber-bushed coupling

The rubber-bushed coupling cushions by means of steel pins bolted alternately to one flange and sliding in self-lubricated bronze bushings, rubber-cushioned in the opposite flange (Fig. 8). The construction permits free axial movement to accommodate motor end play and is especially suited to damping shock and momentary overload. It also affords electrical insulation, thus preventing such dangers as electrolysis in direct motor-driven pumps.

4.1.2.4 Roller chain flexible coupling

The two opposing hubs are made with integral sprockets over which a double roller chain is fitted (Fig. 9). The drive is through the chain. Flexibility is obtained by lateral play in the fit of the chain over the sprocket teeth.

4.1.2.5 Rubber-flexible coupling

In a rubber-flexible coupling, the torque is transmitted through a comparatively soft rubber in compression. It is recommended where quietness is desired (Fig. 10).

4.1.2.6 Universal joint

Universal joints are used to connect shafts with much larger values of misalignment than can be tolerated by the other types of flexible couplings (Fig. 11).

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4.2 Nomenclature of couplings

Nomenclature of rigid and flexible couplings shall be as specified in Figures 4 and 11, respectively.

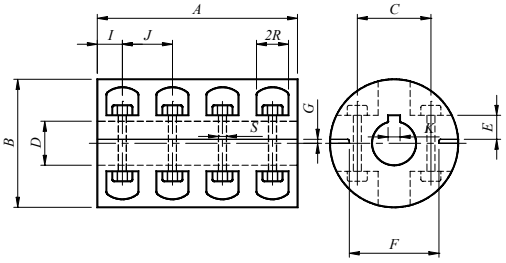


Figure 4 –Clamp shaft coupling

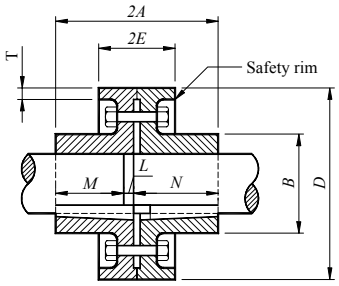
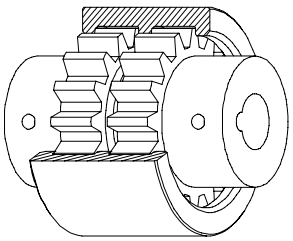


Figure 5 – Flange coupling



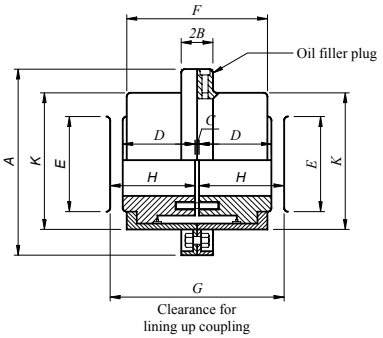
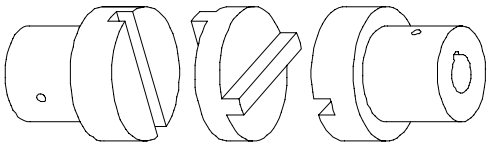


Figure 6 – Gear type coupling



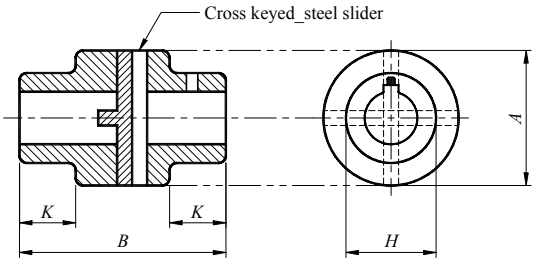


Figure 7– Oldham coupling

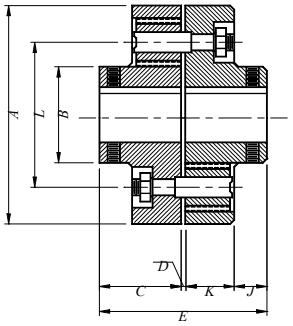


Figure 8 – Rubber-bushed coupling

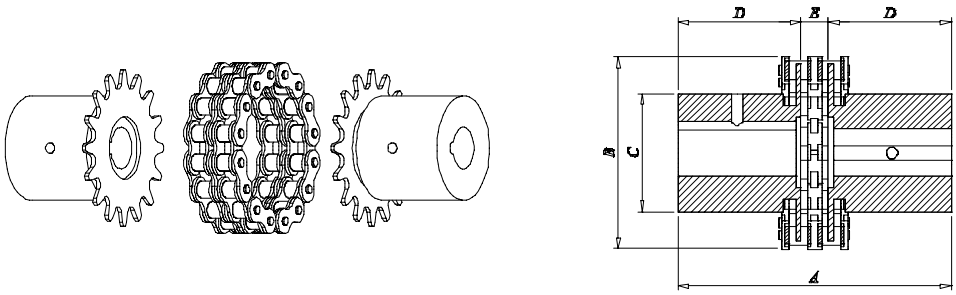


Figure 9 – Roller chain coupling

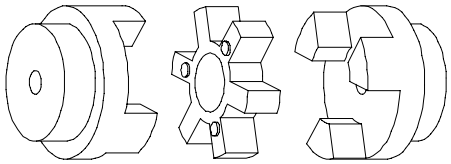


Figure 10 – Rubber-flexible coupling

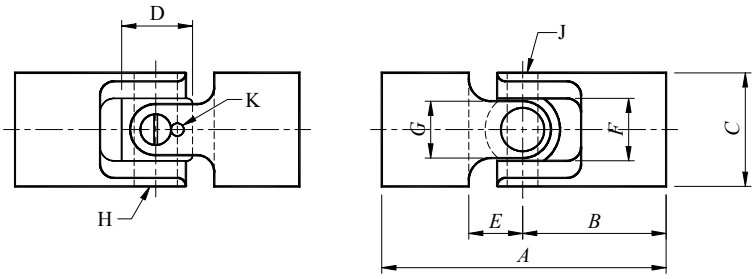


Figure 11 – Universal joint

4.3 Dimensions and ratings of couplings

Dimensions of couplings shall be as specified in Tables 4 to 11. Tables 6 to11 also includes the power ratings of flexible couplings.

Table 4 – Dimensions of clamp shaft couplings

Shaft diameter (*D*), mm	Dimensions, mm										
	A	***B***	***C***	***E***	***F***	***G***	***H***	***J***	***K***	***R***	***S***
36	152	108	64	25	86	3	38	-	8	24	16
49	203	140	83	35	108	6	51	-	11	27	19
75	305	203	108	51	137	6	38	76	17	27	19
100	406	260	140	70	178	6	51	102	21	33	25
125	508	321	171	86	216	6	64	127	21	40	32

Table 5 – Dimensions of flange couplings

Shaft size, mm	Dimensions, mm								Bolts			Keyway	
	A	*B*	*D*	*E*	*L*	*M*	*N*	*T*	Diameter bolt circle, mm	No.	Size, mm	Width, mm	Depth, mm
30	57	57	152	25	3	46	65	5	102	3	13	8	4
49	83	98	197	38	3	68	94	6	143	4	16	13	6
100	133	181	313	57	8	113	146	10	248	4	22	25	13
151	206	267	451	75	10	187	216	13	349	6	32	38	19
203	257	371	610	108	13	225	276	17	470	8	38	44	22

Table 6 – Dimensions and ratings of gear-type coupling

Maximum				Dimensions, mm								
Bore, mm	rpm	Power at 100 rpm, watts	Parallel misalign-ment, mm	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*K*
35	12,000	2,611	0.8	116	16	3	38	51	73	102	49	68
54	10,000	8,952	1.0	152	19	3	52	73	102	130	64	97
108	6,000	96,980	2.0	279	29	6	106	146	205	279	137	195
168	4,000	410,300	3.0	421	38	8	168	222	321	427	210	319

Table 7 – Dimensions and ratings of Oldham coupling

Bore, mm	Power at 100 rpm, watts	Torque, N-m	*A*, mm	*B*, mm	*C*, mm	*H*, mm	*K*, mm
36	3,730	305	114	162	16	67	24
49	7,460	701	146	210	19	89	29
75	25,364	2,373	216	305	25	133	38
100	59,680	5,649	273	400	32	178	48
151	201,420	19,207	406	591	44	267	67

Table 8 – Dimensions and ratings of rubber-bushed coupling

Maximum			Dimensions, mm							
Bore, mm	rpm	Power at 100 rpm, watts	*A*	*B*	*C*	*D*	*E*	*J*	*K*	*L*
22	7,000	1,119	100	43	33	2	68	16	17	67
51	3,800	5,819	176	87	64	3	130	32	32	124
102	2,200	42,522	311	186	114	3	232	64	51	237
210	1,400	198,436	495	337	191	5	386	114	76	403

Table 9 – Dimensions and ratings of roller chain flexible coupling

Maximum			Dimensions, mm						
Bore, mm	rpm	Power at 100 rpm, watts	*A*	*B*	*C*	*D*	*E*	*F*	*H*
19	5,000	1,119	59	57	29	66	33	105	2
44	5,000	5,371	75	64	37	95	64	146	2
100	2,000	36,554	213	143	105	306	159	344	3
198	1,500	67,588	238	143	117	397	273	410	3

Table 10 – Ratings of rubber-flexible couplings

Shaft dia. range	Maximum horsepower rating at rpm for uniform load						
	100	**300**	**690**	**870**	**1,150**	**1,750**	**3,450**
9 to 13	75	231	530	671	895	1,343	2,686
13 to 22	149	448	1,044	1,268	1,716	2,611	5,073
13 to 25	298	895	2,014	2,611	3,432	5,147	10,220
19 to 32	530	1,567	3,655	4,625	6,117	9,325	18,352
25 to 38	970	2,835	6,565	8,206	10,892	16,561	32,675
32 to 48	1,865	5,670	13,055	16,487	21,783	33,122	-
44 to 54	3,282	9,922	22,902	28,870	38,121	57,964	-

Table 11 – Dimensions and ratings of Hooke's universal joint

Maximum		Dimensions, mm									
Bore	**Power at 100 rpm**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**
5	52	44	22	10	7	6	6	5	3	2	-
13	1,492	86	43	25	17	14	14	13	8	6	3
25	11,936	138	69	51	37	28	26	27	17	11	3
57	76,838	270	135	102	70	56	52	48	27	19	6

5 Splines

5.1 Types

5.1.1 Square splines

Square splines are employed in multiple-spline fittings having 4, 6, 10, or 16 splines (Fig. 12).

5.1.2 Involute splines

Involute splines are multiple keys in the general form of internal and external gear teeth, used to prevent relative rotation of cylindrically fitted machine parts (Fig. 13).

5.2 Nomenclature of splines

Nomenclature splines shall be as specified in Figures 12 and 13, respectively.

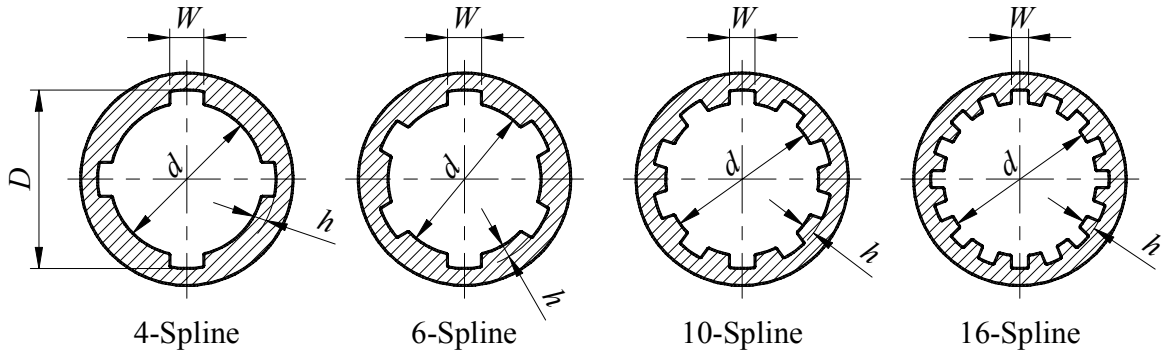


Figure 12 – Nomenclature of square splines

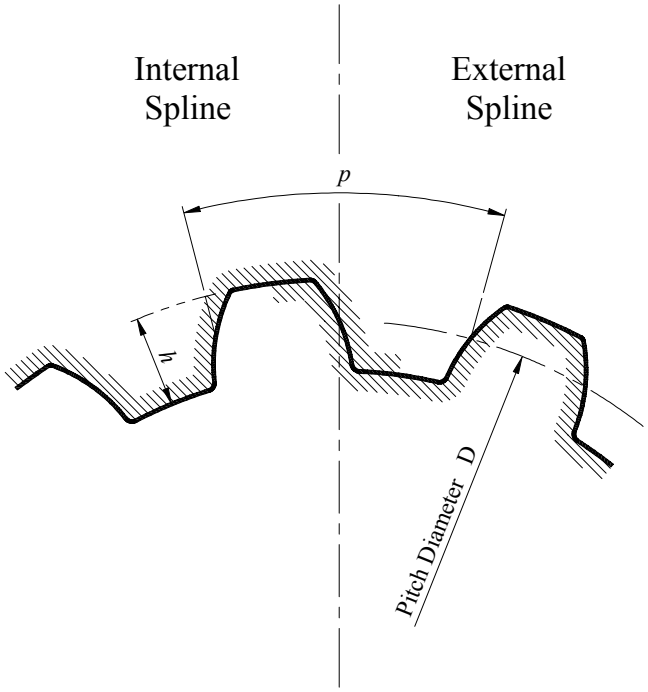


Figure 13 – Nomenclature of involute spline

5.3 Dimensions of splines

Dimensions of splines shall be as specified in Table 12.

Table 12 – Formulas for spline proportions

No. of splines	W for all fits	Permanent fit		To slide when not under load		To slide under load	
		h	***d***	***h***	***d***	***h***	***d***
4	0.241*D*	0.075*D*	0.850*D*	0.125*D*	0.750*D*	-	-
6	0.250*D*	0.050*D*	0.900*D*	0.075*D*	0.850*D*	0.100*D*	0.800*D*
10	0.156*D*	0.045*D*	0.910*D*	0.070*D*	0.860*D*	0.095*D*	0.810*D*
16	0.098*D*	0.098*D*	0.910*D*	0.070*D*	0.860*D*	0.095*D*	0.810*D*

6 Recommended design practice

In order to assure adequate coupling life on pulsating loads, it is necessary to increase the size of the coupling over that determined on a basis of maximum shaft size or rated power capacity. The service factors given in Table 13 are representative values given in most catalogs and are to be used in Equation 1, which allows for fatigue and overheating at higher speeds.

$$P_n = S_f P_r \left(\frac{100}{N_r} \right)^{\frac{3}{4}} \quad \text{.....Eq. 1}$$

Where: P_n = Nominal power capacity at 100 rpm, watts
S_f = Service factor
P_r = Required power, watts
N_r = Required rpm

Table 13 – Service factors

Type of load	Electric motor	4, 6, or 8 cylinder gasoline engine	Gasosline or deisel engine
Uniform (fans, centrifugal pumps, agitators, generators, line shafts)	1	1.5	2
Moderate shock (beaters, grinders, ball mills, reciprocating pumps, or compressors with 3 or more cylinders)	1.5	2	2.5
Heavy shock (boat propellers, 1 to 2-cyllinder compressors and pumps, crushers, hammer and rolling mills)	2	2.5	3

7 Markings

The following information shall be marked on the clutches, couplings, and splines and/or their packaging:

a) Type

b) Bore size

c) Manufacturer’s name and/or its trademark