DORMER

Hardened Steel

Application Material Group

1.7 1.8

Examples of Workpiece Materials - Categorisation into Application Material Groups (AMG)

	Application Material Group (AMG)	Hardness HRc	Tensile Strength N/mm²	Normal Chip Form	EN	Werkstoff Number	DIN
1.7	Alloy steel, Heat treated	49-55	>1620	middle	EN - ISO 4957 - HS2-9-1-8	1.2510	100MnCrW4
1.8	Alloy steel, Hardened and wear resistant steel	55-63	<1960	short	EN - ISO 4957 - X40CrMoV5-1	1.3343, 1.2344,	S6-5-2, GX40CrMoV5-1

2

	Application Material Group (AMG)	BS	SS	USA	UNS	JIS
1.7	Alloy steel, Heat treated	BO1, BD3, BH13	HARDOX 500			
1.8	Alloy steel, Hardened and wear resistant steel	BM2, BH13	2242 HARDOX 600			

Contents

Application Material Groups

Application Material Groups (“AMGs”) are designed to assist in the selection of the optimum cutting tool for a particular application.

Dormer classifies materials into 10 major Application Material Groups. Each major group is divided into sub-groups on the basis of material properties, such as hardness and strength, and chip formation. This booklet concentrates on sub-groups 1.4 – 1.6 – Hardened Steels.

Examples of national designations within each sub-group are shown on page 2.

This booklet contains a selection of tools that are rated “excellent” for machining Hardened Steels. Please see the Dormer catalogue or Product Selector for the full range, or contact your local Dormer representative or Technical Helpdesk if you need further advice.

Introduction to Hardened Steels

This group of alloy steels, which come into the classification of “tool steels”, covers materials which are almost fully hardened or which have been fully hardened.

Their properties are:-

- High hardness, suited to the use of the end product.
- Wear resistance, which is dependent on the hardness.
- Good tempering properties – no change to the shape of the end product with use.
- Toughness in most cases.
- Good workability.

Chemical composition:-

- Predominantly alloy steels with a high Carbon content of 0.4 – 2.3%.
- Typical alloying elements are Chromium (Cr), Tungsten (W), Molybdenum (Mo), Vanadium (V).

1.7
Alloy Steel, Hardened
Hardness 49-55 HRc
Tensile strength <1620 N/mm^2

Typical Composition

This group of alloy steels covers materials which are almost fully hardened.

The tempering temperature at heat treatment is selected to retain some ductility, but the overall objective is to obtain wear resistance by increased hardness. These tool steels have good dimensional stability combined with high resistance to tempering.

Machining of these materials will be difficult, so care must be taken to select the correct conditions. Please see the tool selections in this book, or refer to the Dormer catalogue or Product Selector.

Examples of uses

Typical end uses of AMG 1.7 are sprockets, wear resistant plate, gears, cams and machine tool parts.

1.8
Alloy steel, Hardened and wear resistant
Hardness 55-63 HRc
Tensile strength <1960 N/mm²

Typical Composition

The materials within this group have been fully hardened. Heat treatment has taken place and the tempering temperature has been selected to give maximum hardness. Ductility is generally very low and wear resistance properties are good.

Normally materials with these hardness values are ground or hard turned to size. As with AMG 1.7, machining of these materials will be difficult, so care must be taken to select the correct conditions. Please see the tool selections in this book, or refer to the Dormer catalogue or Product Selector.

Examples of uses

Typical end uses of AMG 1.8 are cutting tools, circular saws, knives, high wear resistant plate, dies and mining tools.

General Hints on Drilling

1. Select the most appropriate drill for the application, bearing in mind the material to be machined, the capability of the machine tool and the coolant to be used.

2. Flexibility within the component and machine tool spindle can cause damage to the drill as well as the component and machine - ensure maximum stability at all times. This can be improved by selecting the shortest possible drill for the application.

3. Tool holding is an important aspect of the drilling operation and the drill cannot be allowed to slip or move in the tool holder.

4. The use of suitable coolants and lubricants are recommended as required by the particular drilling operation. When using coolants and lubricants, ensure a copious supply, especially at the drill point.

5. Swarf evacuation whilst drilling is essential in ensuring the correct drilling procedure. Never allow the swarf to become stationary in the flute.

6. When regrinding a drill, always makes sure that the correct point geometry is produced and that any wear has been removed.

	Ø [mm]											
	1	2	3	4	5	6	8	10	12	15	16	20
S	0.008	0.014	0.020	0.025	0.030	0.037	0.050	0.080	0.100	0.123	0.130	0.150
T	0.015	0.028	0,040	0.050	0.060	0.070	0.090	0.110	0.130	0.160	0.170	0.190
U	0.026	0.048	0.070	0.080	0.090	0.107	0.140	0.170	0.200	0.223	0.230	0.240
V	0.038	0.069	0.100	0.115	0.130	0.153	0.200	0.250	0.280	0.310	0.320	0.340
	mm/rev ± 25%											

	R022	R520	R558	R590
				
	HM	HM	HM	HM
	TiN	TiN	TiAlN	TiAlN
	D	DIN 1897	mm	DIN 1897
	2,5xD	2,5xD	2,5xD	2,5xD
			DIN 6535 HA	
	118°	130°	130°	140°
		S.P.	S.P.	S.P.
	3.0 - 17/32	3.0 - 16.5	3.0 - 20.0	8.0 - 16.0
		CDX	CDX	CDX
1.7	■30U	•35U	■40V	■30U
1.8	■30U	•30T	■30V	■25U

■ Excellent
• Good

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R002	R510	R554	
			
HM	HM	HM	
TiN	TiN	TiAlN	
DIN 338	DIN 338	DIN	
5XD	4xD	4xD	
118°	130°	130°	
	S.P.	S.P.	
3.0 - 14.0	3.0 - 14.25	3.0 - 20.0	
	CDX	CDX	
■30T	•35T	■30U	1.7
■30T	•30S	■25U	1.8

General Hints on Tapping

1. Select the correct design of tap for the component material and type of hole, i.e. through or blind, from the Application Material Groups chart.

2. Ensure the component is securely clamped - lateral movement may cause tap breakage or poor quality threads.

3. Select the correct size of drill (see opposite). Always ensure that work hardening of the component material is kept to a minimum.

4. Select the correct cutting speed as shown in the tap selection pages, the catalogue or the Product Selector.

5. Use appropriate cutting fluid for correct application.

6. In NC applications ensure that the feed value chosen for the program is correct. When using a tapping attachment, 95% to 97% of the pitch is recommended to allow the tap to generate its own pitch.

7. Where possible, hold the tap in a good quality torque limiting tapping attachment, which ensures free axial movement of the tap and presents it squarely to the hole. It also protects the tap from breakage if accidentally ‘bottomed’ in a blind hole.

8. Ensure smooth entry of the tap into the hole, as an uneven feed may cause ‘bell mouthing’.

Drill Diameters for Cutting Taps - Recommendation tables

METRIC COARSE THREAD				
TAP M	Pitch mm	Max. Internal Diam. mm	DRILL Diam. mm	DRILL Diam. inch
1.6	0.35	1.321	1.25	3/64
1.8	0.35	1.521	1.45	54
2	0.4	1.679	1.6	1/16
2.2	0.45	1.833	1.75	50
2.5	0.45	2.138	2.05	46
3	0.5	2.599	2.5	40
3.5	0.6	3.010	2.9	33
4	0.7	3.422	3.3	30
4.5	0.75	3.878	3.8	27
5	0.8	4.334	4.2	19
6	1	5.153	5	9
7	1	6.153	6	15/64
8	1.25	6.912	6.8	H
9	1.25	7.912	7.8	5/16
10	1.5	8.676	8.5	Q
11	1.5	9.676	9.5	3/8
12	1.75	10.441	10.3	Y
14	2	12.210	12	15/32
16	2	14.210	14	35/64
18	2.5	15.744	15.5	39/64
20	2.5	17.744	17.5	11/16
22	2.5	19.744	19.5	49/64
24	3	21.252	21	53/64
27	3	24.252	24	61/64
30	3.5	26.771	26.5	1.3/64

Drill diameter can be calculated from:

$$D = D_{nom} - P$$

D = Drill diameter (mm)

D_{nom} = Tap nominal diameter (mm)

P = Tap pitch (mm)

METRIC COARSE THREAD FOR ADX/CDX		
TAP M	Pitch mm	DRILL Diameter mm
4	0.70	3.40
5	0.80	4.30
6	1.00	5.10
8	1.25	6.90
10	1.50	8.70
12	1.75	10.40
14	2.00	12.25
16	2.00	14.25

RECOMMENDED DIAMETERS WHEN USING DORMER ADX AND CDX DRILLS

The above table for drill diameters refer to ordinary standard drills. Modern drills such as Dormer ADX and CDX produce a smaller and more accurate hole which makes it necessary to increase the diameter of the drill in order to avoid breakage of the tap. Please see the small table to the left.

Other thread types available.
Please see Dormer catalogue.

DIN

	T100	T110
	M	M
		
	HM	HM
	D	D
	6H	6HX
	2xD	2xD
	C 2 - 3	C 2 - 3
	M3 - M12	M3 - M12
1.7	■6	•6
1.8	•4	■4

■ Excellent
• Good

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Other thread types available.
Please see Dormer catalogue.

J100	J101	J105
M	M	M
		
HM	HM	HM
		
D	D	D
2xD	1,5xC	2xD
		
M4-M16	M6 - M16	M8 - M16
•50A	■50A	•50A	1.7
•30A	■30A	•30A	1.8

Ø	A ap= 1 x d_1	A ap= 2 x d_1
3,2	0,010	0,005
4,1	0,009	0.007
4,8	0,012	0,009
6,5	0,017	0,014
8,2	0,021	0,018
9,9	0,024	0,020
11,6	0,031	0,025
13,6	0,039	0,032

ap =

d_1 =

General Hints on Milling

1. Where possible, use climb milling (down milling) for longer tool life. Climb milling allows easier chip disposal, less wear, improved surface finish and lower power requirements compared to conventional milling (up milling).

2. Always use a cutter in good condition.

3. Use well-maintained machine tools with sufficient power.

4. Use correct clamping system according to working operation and type of tool.

5. Check for damage or wear on the tool shank or in the holder itself.

6. Use the shortest cutters recommended for your application and work as close to the machine head as possible.

7. For optimum productivity, use coated or Solid Carbide cutters.

Milling parameters

1. Identify the type of end milling to be carried out
   - type of end mill
   - type of centre

2. Consider the condition and the age of the machine tool.

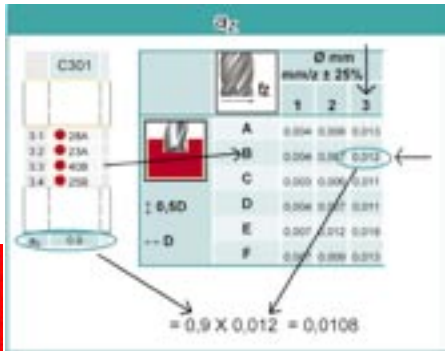
3. Select the best end mill dimensions in order to minimize the deflection and bending stress
   - the highest rigidity
   - the largest mill diameter
   - avoid excessive overhand of the tool from the tool holder.

4. Choose the number of flutes
   - more flutes - decreased space for chips - increased rigidity - allows faster table feed
   - less flutes - increased space for chips - decreased rigidity - easy chip ejection.

5. Determining the correct cutting speed and feed rate can only be done when the following factors are known:
   - type of material to be machined
   - end mill material
   - power available at the spindle
   - type of finish.

Z	HM			Ø mm mm/z ± 25%															
				>0,5	0.6	0.8	1	2	3	4	5	6	8	10	12	14	16	18	20
>4		↕ 1,5 ↔ 0,05	A									0.015	0.020	0.025	0.030	0.035	0.040	0.050	0.060
			B									0.045	0.050	0.060	0.075	0.080	0.090	0.100	0.110
			C									0.065	0.075	0.090	0.110	0.120	0.130	0.150	0.170
3-4		↕ 1,5 ↔ 0,1	A					0.010	0.020	0.030	0.040	0.045	0.050	0.060	0.075	0.080	0.090	0.100	0.120
			B					0.015	0.030	0.040	0.055	0.065	0.075	0.090	0.110	0.120	0.130	0.150	0.170
			C					0.015	0.030	0.040	0.055	0.085	0.100	0.120	0.140	0.150	0.170	0.200	0.220
3-4		↕ 1 ↔ 0,5	A				0.001	0.003	0.005	0.008	0.010	0.013	0.020	0.027	0.035	0.040	0.050	0.055	0.060
			B				0.002	0.004	0.008	0.012	0.015	0.020	0.030	0.040	0.050	0.060	0.070	0.080	0.090
			C				0.003	0.005	0.010	0.015	0.020	0.025	0.040	0.050	0.065	0.080	0.090	0.105	0.120
2-3		↕ 0,5 ↔ 1	A	0.001	0.001	0.002	0.002	0.005	0.009	0.013	0.017	0.020	0.023	0.035	0.040	0.050	0.055	0.060	0.070
			B	0.001	0.002	0.003	0.003	0.007	0.013	0.020	0.025	0.030	0.035	0.050	0.060	0.070	0.080	0.090	0.100
			C	0.002	0.003	0.004	0.004	0.009	0.017	0.025	0.033	0.040	0.045	0.065	0.080	0.090	0.105	0.120	0.130
3-4		↕ 0,5 ↔ 1 ↕ 1 ↔ 0,5	B									0.035	0.040	0.055	0.065	0.080	0.090	0.100	0.110

2 & 4		↕ 0,1 - 0,5mm ↔ 0,1 - 0,5mm	**A**					0.010	0.017	0.023	0.028	0.032	0.040	0.050	0.055	0.070	0.080	
			BC					0.015	0.022	0.030	0.035	0.040	0.050	0.060	0.070	0.085	0.100	
4		↕ 0,01 - 0,1 ↔ ≤ 1	**A**									0.040	0.050	0.055	0.065		0.080	
			BC									0.050	0.060	0.070	0.080		0.100	



Application


Slotting


Roughing


Corner radius


Ball nose


Finishing

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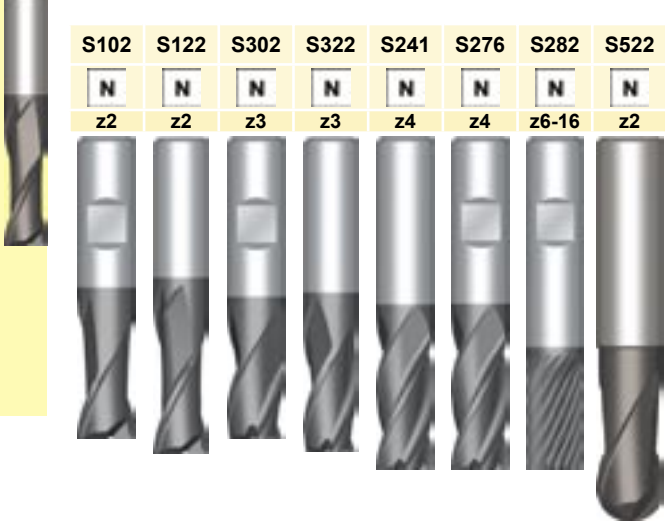
S102	S122	S302	S322	S241	S276	S282	S522
N	N	N	N	N	N	N	N
z2	z2	z3	z3	z4	z4	z6-16	z2



HM	HM	HM	HM	HM	HM	HM	HM
DIN 6527	DIN 6527	DIN 6527	DIN 6527	DIN 6527	DIN 6527	DIN 6527	D
P9	P9	P9	P9				
e8 h10	h10	e8 h10	h10	h10	h10	h10	h9
2.0 - 20.0	2.0 - 20.0	2.0 - 20.0	2.0 - 20.0	3.5 - 20.0	2.0 - 25.0	6.0 - 16.0	1.0 - 16.0
							HSM
1.7 ■50A	■45A	■50A	■45A	■61A	■61A	■80A	■140A
1.8 •40A	•36A	•40A	•36A			■50A	■80A
a_z 1	1	1	1	1	1	1	1

■ Excellent
• Good

S502	S503	S532	S190	S290	S170	S150	S152
N	N	N	N	N	N	N	N
z2	z2	z4	z2	z4	z2-4	z2	z2
							
HM	HM	HM	HM	HM	HM	HM	HM
D	D	D	D	D	D	D	D
h9	h9	h9	h9	h9	h9	h9	h9
1.0 - 16.0	1.0 - 16.0	6.0 - 16.0	3.0 - 16.0	6.0 - 16.0	2.0 - 12.0	0.4 - 1.0	0.5 - 1.0
HSM	HSM	HSM	HSM	HSM	HSM	HSM	HSM
■127A	■140A	■140A	■140A	■140A	■70A	■70A	■70A	1.7
■72A	■80A	■80A	■80A	■80A	■40A	■40A	■40A	1.8
1	1	1	1	1	1	1	1	a_z

Table of Cutting Speeds, <10mm

PERIPHERAL CUTTING SPEED																	
Metres/Min.		5	8	10	15	20	25	30	40	50	60	70	80	90	100	110	150
Feet/Min.		16	26	32	50	66	82	98	130	165	197	230	262	296	330	362	495
Tool Diameter		REVOLUTIONS PER MINUTE (RPM)															
mm	inch																
1,00		1592	2546	3138	4775	6366	7958	9549	12732	15916	19099	22282	25465	28648	31831	35014	47747
1,50		1061	1698	2122	3183	4244	5305	6366	8488	10610	12732	14854	16977	19099	21221	23343	31831
2,00		796	1273	1592	2387	3183	3979	4775	6366	7958	9549	11141	12732	14324	15916	17507	23873
2,50		637	1019	1273	1910	2546	3183	3820	5093	6366	7639	8913	10186	11459	12732	14006	19099
3,00		531	849	1061	1592	2122	2653	3183	4244	5305	6366	7427	8488	9549	10610	11671	15916
3,18	1/8	500	801	1001	1501	2002	2502	3003	4004	5005	6006	7007	8008	9009	10010	11011	15015
3,50		455	728	909	1364	1819	2274	2728	3638	4547	5457	6366	7176	8185	9095	10004	13642
4,00		398	637	796	1194	1592	1989	2387	3183	3979	4775	5570	6366	7162	7958	8754	11937
4,50		354	566	707	1061	1415	1768	2122	2829	3537	4244	4951	5659	6366	7074	7781	10610
4,76	3/16	334	535	669	1003	1337	1672	2006	2675	3344	4012	4681	5350	6018	6687	7356	10031
5,00		318	509	637	955	1273	1592	1910	2546	3183	3820	4456	5093	5730	6366	7003	9549
6,00		265	424	531	796	1061	1326	1592	2122	2653	3183	3714	4244	4775	5305	5836	7958
6,35	1/4	251	401	501	752	1003	1253	1504	2005	2506	3008	3509	4010	4511	5013	5514	7519
7,00		227	364	455	682	909	1137	1364	1819	2274	2728	3183	3638	4093	4547	5002	6821
7,94	5/16	200	321	401	601	802	1002	1203	1604	2004	2405	2806	3207	3608	4009	4410	6013
8,00		199	318	398	597	796	995	1194	1592	1989	2387	2785	3183	3581	3979	4377	5968
9,00		177	283	354	531	707	884	1061	1415	1768	2122	2476	2829	3183	3537	3890	5305
9,53	3/8	167	267	334	501	668	835	1002	1336	1670	2004	2338	2672	3006	3340	3674	5010
10,00		159	255	318	477	637	796	955	1273	1592	1910	2228	2546	2865	3183	3501	4775

Table of Cutting Speeds, >10mm

PERIPHERAL CUTTING SPEED																	
Metres/Min.		5	8	10	15	20	25	30	40	50	60	70	80	90	100	110	150
Feet/Min.		16	26	32	50	66	82	98	130	165	197	230	262	296	330	362	495
Tool Diameter		REVOLUTIONS PER MINUTE (RPM)															
mm	inch																
11,11	7/16	143	229	287	430	573	716	860	1146	1433	1719	2006	2292	2579	2865	3152	4298
12,00		133	212	265	398	531	663	796	1061	1326	1592	1857	2122	2387	2653	2918	3979
12,70	1/2	125	201	251	376	501	627	752	1003	1253	1504	1754	2005	2256	2506	2757	3760
14,00		114	182	227	341	455	568	682	909	1137	1364	1592	1819	2046	2274	2501	3410
14,29	9/16	111	178	223	334	446	557	668	891	1114	1337	1559	1782	2005	2228	2450	3341
15,00		106	170	212	318	424	531	637	849	1061	1273	1485	1698	1910	2122	2334	3183
15,88	5/8	100	160	200	301	401	501	601	802	1002	1203	1403	1604	1804	2004	2205	3007
16,00		99	159	199	298	398	497	597	796	995	1194	1393	1592	1790	1989	2188	2984
17,46	11/16	91	146	182	273	365	456	547	729	912	1094	1276	1458	1641	1823	2005	2735
18,00		88	141	177	265	354	442	531	707	884	1061	1238	1415	1592	1768	1945	2653
19,05	3/4	84	134	167	251	334	418	501	668	835	1003	1170	1337	1504	1671	1838	2506
20,00		80	127	159	239	318	398	477	637	796	955	1114	1273	1432	1592	1751	2387
24,00		66	106	133	199	265	332	398	531	663	796	928	1061	1194	1326	1459	1989
25,00		64	102	127	191	255	318	382	509	637	764	891	1019	1146	1273	1401	1910
27,00		59	94	118	177	236	295	354	472	589	707	825	943	1061	1179	1297	1768
30,00		53	85	106	159	212	265	318	424	531	637	743	849	955	1061	1167	1592
32,00		50	80	99	149	199	249	298	398	497	597	696	796	895	995	1094	1492
36,00		44	71	88	133	177	221	265	354	442	531	619	707	796	884	973	1326
40,00		40	64	80	119	159	199	239	318	398	477	557	637	716	796	875	1194
50,00		32	51	64	95	127	159	191	255	318	382	446	509	573	637	700	955