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Table 2501.03-1 (English Units)
Energy Values For Gravity And Diesel Hammers

Minimum Energy Required for Gravity Hammers (Ft. - Kips[b])									
Pile Length (ft.)	Wood Pile	Concrete Pile		Steel H-Pile					
		12" to 14"	16"	10 x 42	10 x 57	12 x 53	12 x 74	14 x 73	14 x 89
25' or less	15	25	27	23	23	23	25	25	32
26' to 40'	15	25	27	23	23	23	30	30	35
41' to 50'	15	25	27	25	25	25	30	30	36
51' to 65'	(a)	(a)	(a)	25	25	25	30	30	36
66' to 90'	(a)	(a)	(a)	30	30	30	33	33	36

Maximum Energy Allowed for Gravity Hammers (Ft. - Kips[b])									
Pile Length (ft.)	Wood Pile	Concrete Pile		Steel H-Pile					
		12" to 14"	16"	10 x 42	10 x 57	12 x 53	12 x 74	14 x 73	14 x 89
25' or less	25	34	36	28	28	28	35	35	42
26' to 40'	25	34	36	32	35	35	38	38	45
41' to 50'	25	34	36	38	38	42	42	42	48
51' to 65'	(a)	(a)	(a)	35	38	38	42	42	48
66' to 90'	(a)	(a)	(a)	35	38	38	42	42	50

Minimum Energy Required for Diesel Hammers (Ft. - Kips[b])									
Pile Length (ft.)	Wood Pile	Concrete Pile	Steel H-Pile						
		12" to 14"	16"	10 x 42	10 x 57	12 x 53	12 x 74	14 x 73	14 x 89
25' or less	17	23	28	22	24	24	29	29	33
26' to 40'	17	23	28	22	24	24	29	29	40
41' to 50'	17	23	28	22	26	26	33	33	40
>51' to 65'	[a]	[a]	[a]	22	26	26	33	33	40
66' to 90'	[a]	[a]	[a]	22	29	29	40	40	49

Maximum Energy Allowed for Diesel Hammers (Ft. - Kips[b])									
Pile Length (ft.)	Wood Pile	Concrete Pile	Steel H-Pile						
		12" to 14"	16"	10 x 42	10 x 57	12 x 53	12 x 74	14 x 73	14 x 89
25' or less	24	32	40	33	33	33	40	40	43
26' to 40'	24	32	40	33	33	33	40	40	47
41' to 50'	33	32	40	40	40	40	43	43	52
51' to 65'	[a]	[a]	[a]	40	40	40	43	43	52

[a] Wave equation analysis.

[b] Ft. - Kips - 1,000 foot pounds.

For design bearings under 40 tons, minimum diesel hammer energies listed may be reduced by 20% for concrete pile and 10% for steel pile.

Table 2501.03-2 (Metric Units)
Energy Values For Gravity And Diesel Hammers

Minimum Energy Required for Gravity Hammers (kilojoules)									
Pile Length (meters)	Wood Pile	Concrete Pile		Steel H-Pile					
		305 mm to 356 mm	406 mm	250 x 62	250 x 85	310 x 79	310 x 110	360 x 108	360 x 132
7.5 or less	20	34	37	31	31	31	34	34	43
7.6 to 12.0	20	34	37	31	31	31	41	41	47
12.1 to 15.0	20	34	37	34	34	34	41	41	49
15.1 to 20.0	(a)	(a)	(a)	34	34	34	41	41	49
20.1 to 28.0	(a)	(a)	(a)	41	41	41	45	45	49

Maximum Energy Allowed for Gravity Hammers (kilojoules)									
Pile Length (meters)	Wood Pile	Concrete Pile		Steel H-Pile					
		305 mm to 356 mm	406 mm	250 x 62	250 x 85	310 x 79	310 x 110	360 x 108	360 x 132
7.5 or less	34	46	49	38	38	38	47	47	57
7.6 to 12.0	34	46	49	43	47	47	52	52	61
12.1 to 15.0	34	46	49	47	52	52	57	57	65
15.1 to 20.0	(a)	(a)	(a)	47	52	52	57	57	65
20.1 to 28.0	(a)	(a)	(a)	52	52	57	57	57	68

Minimum Energy Required for Diesel Hammers (kilojoules)									
Pile Length (meters)	Wood Pile	Concrete Pile		Steel H-Pile					
		305 mm to 356 mm	406 mm	250 x 62	250 x 85	310 x 79	310 x 110	360 x 108	360 x 132
7.5 or less	23	31	38	30	33	33	39	39	45
7.6 to 12.0	23	31	38	30	33	33	39	39	54
12.1 to 15.0	23	31	38	30	35	35	45	45	54
15.1 to 20.0	(a)	(a)	(a)	30	35	35	45	45	54
20.1 to 28.0	(a)	(a)	(a)	30	39	39	54	54	66

Maximum Energy Allowed for Diesel Hammers (kilojoules)									
Pile Length (meters)	Wood Pile	Concrete Pile		Steel H-Pile					
		305 mm to 356 mm	406 mm	250 x 62	250 x 85	310 x 79	310 x 110	360 x 108	360 x 132
7.5 or less	33	43	54	45	45	45	54	54	58
7.6 to 12.0	33	43	54	45	45	45	54	54	64
12.1 to 15.0	45	43	54	54	54	54	58	58	70
15.1 to 20.0	(a)	(a)	(a)	54	54	54	58	58	70
20.1 to 28.0	(a)	(a)	(a)	54	54	64	66	66	81

(a) Wave equation analysis. For design bearings under 355 kN, minimum diesel hammer energies listed may be reduced by 20% for concrete pile and 10% for steel pile.

Table 2550.02-1: Fabric Form Minimum Property Requirements

Property	Test Method	Units	Armor Unit	Articulating Block Mat
Composition of Yarns			Nylon or Polyester	Nylon or Polyester
Mass Per Unit Area (double-layer)	ASTM D 5261	oz/yd^2 (g/m^2)	14 (470)	12 (403)
Thickness	ASTM D 5199	Mils (mm)	28 (0.7)	25 (0.6)
Mill Width		In (m)	76 (1.92)	76 (1.92)
Wide-Width Strip Tensile Strength -Machine - Cross	 ASTM D 4595 ASTM D 4595	 lbf/in (kN/m) lbf/in (kN/m)	 190 (33.2) 140 (24.5)	 140 (24.5) 110 (19.3)
Elongation at Break - Machine - Cross	 ASTM D 4595 ASTM D 4595	 % %	 20 30	 20 30
Trapezoidal Tear Strength - Machine - Cross	 ASTM D 4533 ASTM D 4533	 lbf (N) lbf (N)	 180 (800) 115 (510)	 150 (665) 100 (445)
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Std. Sieve (mm)	60 (0.250)	40 (0.425)
Flow Rate	ASTM D 4491	gal/min/ft^2 (l/min/m^2)	50 (2035)	90 (3665)

Notes:
a. Conformance of fabric to specification property requirements is based on ASTM D 4759.
b. All numerical values represent minimum average roll values (i.e., average of test results from any sample roll in a lot shall meet or exceed the minimum values). Sample lots according to ASTM D 4354.

Table 2552.02-1: Class II Material

Class	Type	Soil Group Symbol ASTM D 2487	Description	Percentage Passing Sieve Sizes		
				1½ in. (37.5 mm)	No. 4 (4.75 mm)	No. 200 (75 μm)
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines	100%	‹50% of "Coarse Fraction"	‹5%
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.			
		SW	Well-graded sands and gravelly sands; little or no fines.		›50% of "Coarse Fraction"	
		SP	Poorly-graded sands and gravelly sands; little or no fines.			
	Coarse-Grained Soils, borderline clean to with fines	e.g. GW-GC, SP-SM	Sands and gravels which are borderline between clean and with fines.	100%	Varies	5% to 12%

Table 2552.02-2: Class III Material

Class	Type	Soil Group Symbol ASTM D 2487	Description
III	Coarse-Grained Soils, with fines	GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.

Table 2552.02-3: Class IVA Material

Class	Type	Soil Group Symbol ASTM D 2487	Description
IVA	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clay, lean clays.

Table 2552.02-4: Class IVB Material

Class	Type	Soil Group Symbol ASTM D 2487	Description
IVB	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.

Table 2552.02-5: Class V Material

Class	Type	Soil Group Symbol ASTM D 2487	Description
V	Organic Soils (Unsuitable for backfill)	OL	Organic silts and organic silty clays of low plasticity.
		OH	Organic clays of medium to high plasticity, organic silts.
	Highly Organic (Unsuitable for backfill)	PT	Peat and other high organic soils.

AGGREGATE GRADATION TABLE - ENGLISH

Grad. No.	Section No.	Std. Sieve Sz.	1 1/2”	1.00”	3/4”	1/2”	3/8”	4	8	30	50	100	200	
		Intended Use	Percent Passing											Notes
1	4110, 4125, 4133, 4134	PCC FA, Cover Agg.					100	90-100	70-100	10-60			0-1.5	1
2	4112	PCC Intermediate				95-100			0-10					
3	4115 (57, 2-8), 4118	PCC CA	100	95-100		25-60		0-10	0-5				0-1.5	2, 10
4	4115 (2-8)	PCC CA	100	50-100	30-100	20-75	5-55	0-10	0-5				0-1.5	10
5	4115 (67, 2-8)	PCC CA		100	90-100		20-55	0-10	0-5				0-1.5	10
6	4115.06 (Repair & Overlay)	PCC CA			100	97-100	40-90	0-30					0-1.5	10
7	4117 (Class V)	PCC FA & CA	100					80-92	60-75	20-40				
8	4117.03 (Class V)	Fine Limestone					100	90-100					0-30	
10	4119, 4120.02, 4120.03 (C gravel)	Granular Surface			100			50-80	25-60					3, 11
11	4119, 4120.02, 4120.04, 4120.05, 4120.07, (A, B Cr. St.)	Granular Surface & Shoulder		100	95-100	70-90		30-55	15-40				6-16	4, 5, 11
12a	4121 (Cr. St.)	Granular Subbase	100			40-80			5-25				0-6	6, ~~10~~ 11
12b	4121 (Cr. Gravel)	Granular Subbase	100			50-80			10-30		5-15		3-7	7, 11

13	4122.02 (Cr. St.)	Macadam St. Base	3” nominal maximum size screened over 3/4” or 1.00” screen.											
14	4123	Modified Subbase	100		70-90				10-40				3-10	5, 7, 11
19	4125 (1/2”) Cr. Gr. or Cr. St.)	Cover Aggregate			100	97-100	40-90	0-30	0-15				0-2	11
20	4125 (1/2” Scr. Gr.)	Cover Aggregate			100	95-100	40-80	0-15	0-7				0-1.5	11
21	4125 (3/8”)	Cover Aggregate				100	90-100	10-55	0-20	0-7			0-1.5	11
22	4124	Fine Slurry Mixture					100	85-100	40-95	20-60	14-35	10-25	5-25	9, 11
23	4124 (Cr. St.)	Coarse Slurry Mixture					100	70-90	40-70	19-42			5-15	11
29	4131	Porous Backfill			100	95-100	50-100	0-50	0-8					11
30	4132.02 (Cr. St.)	Special Backfill	100						10-40				0-10	5, 11
31	4132.03 (Gravel)	Special Backfill		100	90-100	75-100			30-55				3-7	11
32	4133 (Sand/Gr./Cr. St.)	Granular Backfill	100% passing the 3” screen						10-100				0-10	8, 11
35	4134 (Natural Sand/Gr.)	Floodable Backfill	100						20-90				0-4	11
36	4134 (Natural Sand)	Floodable Backfill							100				0-2	11

Notes: (Gradations No. 9, 15, 16, 17, 18, 24, 25, 26, 27, 28, 33, and 34 have been deleted)

1. For Section 4110, when the fine aggregate is sieved through the following numbered sieves - 4, 8, 16, 30, 50, and 100 - no more than 40% shall pass one sieve and be retained on the sieve with the next higher number.

2. When used in precast and prestressed concrete bridge beams, 100% shall pass the 1.00" sieve. When used for pipe bedding the No. 200 restriction does not apply.

3. When compaction of material is a specification requirement, the minimum percent passing the No. 200 sieve is 6%.

4. See specifications for combination of gravel and limestone.

5. Unwashed air dried samples of crushed composite material shall be tested for gradation compliance except that no gradation determination will be made for material passing the No. 200 sieve.

6. The gradation requirement for the No. 8 sieve shall be 5% to 20% when recycled material is supplied.

7. For Section 4121 gravel, one fractured face on 30% or more of the particles retained on the 3/8 inch sieve. For Section 4123 gravel, one fractured face on 75% or more of the particles retained on the 3/8 inch sieve.

8. Crushed stone shall have 100% passing the 1½" sieve.

9. Gradation limitations for the 30, 50, and 100 sieves shall not apply when slurry mixture is applied by hand lutes, such as for slurry leveling.

10. Maximum of 2.5% passing the No. 200 sieve allowed if for crushed limestone or dolomite when documented production is 1% or less.

11. When Producer gradation test results are used for acceptance, test results representing at least 90% of the material being produced shall be within the gradation limits and the average of all gradation results shall be within the gradations limits. Stockpiled material not meeting the criteria may, at the District Materials Engineer's discretion, be resampled using Materials I.M. 301 procedures. One hundred percent of the stockpile quality control and verification test results shall be within the gradation limits.

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AGGREGATE GRADATION TABLE - METRIC														
Grad. No.	**Section No.**	**Std. Sieve Sz.**	**37.5 mm**	**25 mm**	**19 mm**	**12.5mm**	**9.5 mm**	**4.75 mm**	**2.36 mm**	**600 µm**	**300 µm**	**150 µm**	**75 µm**	
		Intended Use	**Percent Passing**											**Notes**
1	4110, 4125, 4133, 4134	PCC FA, Cover Agg.					100	90-100	70-100	10-60			0-1.5	1
2	4112	PCC Intermediate				95-100			0-10					
3	4115 (57, 2-8), 4118	PCC CA	100	95-100		25-60		0-10	0-5				0-1.5	2, 10
4	4115 (2-8)	PCC CA	100	50-100	30-100	20-75	5-55	0-10	0-5				0-1.5	10
5	4115 (67, 2-8)	PCC CA		100	90-100		20-55	0-10	0-5				0-1.5	10
6	4115.06 (Repair & Overlay)	PCC CA			100	97-100	40-90	0-30					0-1.5	10
7	4117 (Class V)	PCC FA & CA	100					80-92	60-75	20-40				
8	4117.03 (Class V)	Fine Limestone					100	90-100					0-30	
10	4119, 4120.02, 4120.03 (C gravel)	Granular Surface			100			50-80	25-60					3, 11
11	4119, 4120.02, 4120.04, 4120.05, 4120.07 (A, B Cr. St.)	Granular Surface & Shoulder		100	95-100	70-90		30-55	15-40				6-16	4, 5, 11

12a	4121 (Cr. St.)	Granular Subbase	100			40-80			5-25				0-6	6, 11
12b	4121 (Cr. Gravel)	Granular Subbase	100			50-80			10-30		5-15		3-7	7, 11
13	4122.02 (Cr. St.)	Macadam St. Base	75 mm nominal maximum size screened over 19 mm or 25 mm screen.											
14	4123	Modified Subbase	100		70-90				10-40				3-10	5, 7, 11
19	4125 (12.5mm Cr. Gr. or Cr. St.)	Cover Aggregate			100	97-100	40-90	0-30	0-15				0-2	11
20	4125 (12.5mm Scr. Gr.)	Cover Aggregate			100	95-100	40-80	0-15	0-7				0-1.5	11
21	4125 (9.5mm)	Cover Aggregate				100	90-100	10-55	0-20	0-7			0-1.5	11
22	4124.02B	Fine Slurry Mixture					100	85-100	40-95	20-60	14-35	10-25	5-25	9, 11
23	4124.02B (Cr. St.)	Coarse Slurry Mixture					100	70-90	40-70	19-42			5-15	11
29	4131	Porous Backfill			100	95-100	50-100	0-50	0-8					11
30	4132.02 (Cr. St.)	Special Backfill	100						10-40				0-10	5, 11
31	4132.03 (Gravel)	Special Backfill		100	90-100	75-100			30-55				3-7	11
32	4133 (Sand/Gr./Cr. St.)	Granular Backfill	100% passing the 76.2 mm screen						10-100				0-10	8, 11

35	4134 (Natural Sand/Gr.)	Floodable Backfill	100						20-90				0-4	11
36	41334 (Natural Sand)	Floodable Backfill							100				0-2	11

Notes: (Gradations No. 9, 15, 16, 17, 18, 24, 25, 26, 27, 28, 33, and 34 have been deleted)

1. For Section 4110, when the fine aggregate is sieved through the following numbered sieves - 4.75 mm, 2.36 mm, 1.18 mm, 600 µm, 300 µm, and 150 µm - not more than 40% shall pass one sieve and be retained on the sieve with the next higher number.

2. When used in precast and prestressed concrete bridge beams, 100% shall pass the 25 mm sieve. When used for pipe bedding the 75µm restriction does not apply.

3. When compaction of material is a specification requirement, the minimum percent passing the 75 µm sieve is 6%.

4. See specifications for combination of gravel and limestone.

5. Unwashed air dried samples of crushed composite material shall be tested for gradation compliance except that no gradation determination will be made for material passing the 75 µm sieve.

6. The gradation requirement for the 2.36 mm sieve shall be 5% to 20% when recycled material is supplied.

7. For Section 4121 gravel, one fractured face on 30% or more of the particles retained on the 9.5 mm sieve. For Section 4123 gravel, one fractured face on 75% or more of the particles retained on the 9.5 mm sieve.

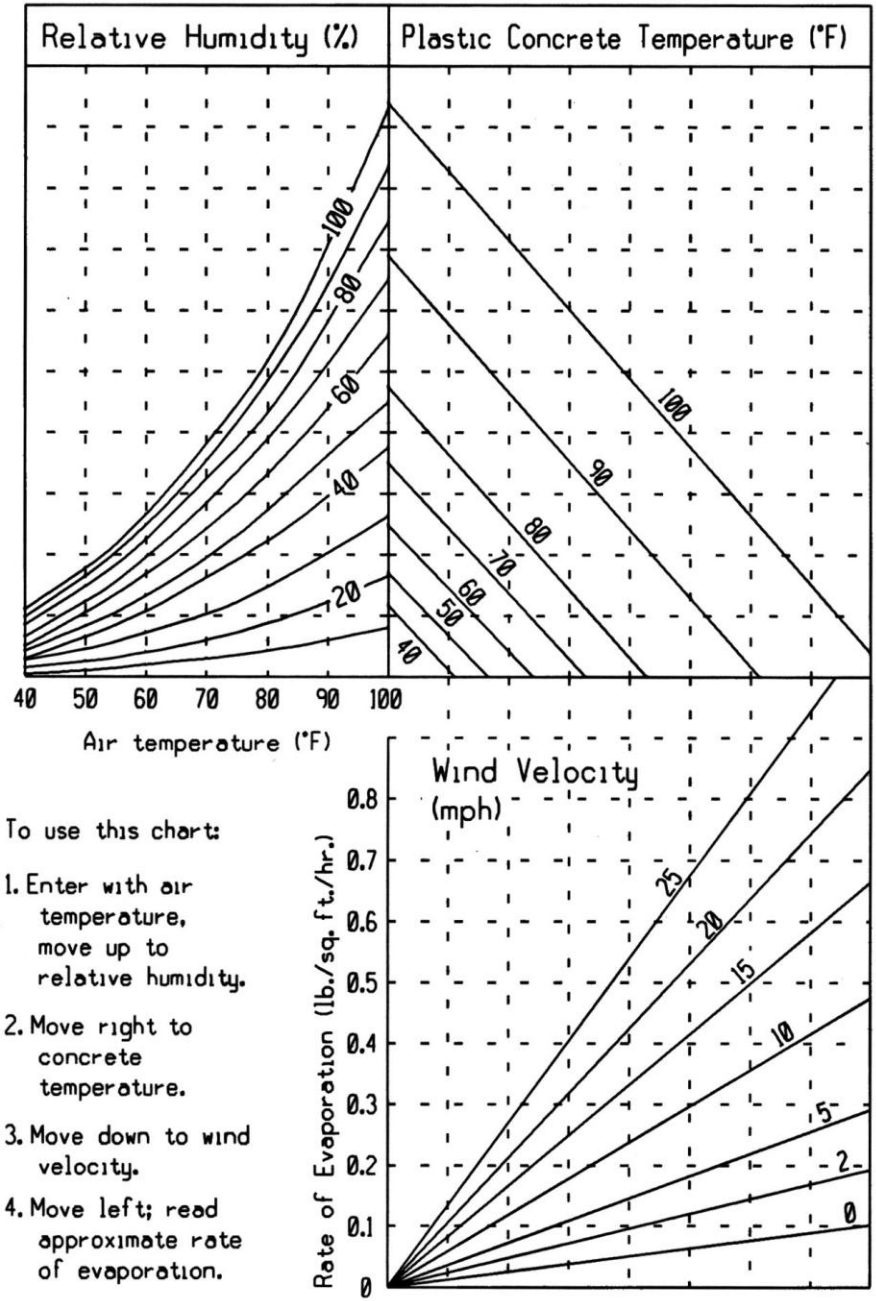
8. Crushed stone shall have 100% passing the 37.5 mm sieve.

9. Gradation limitations for the (600 µm, 300 µm, and 150 µm) sieves shall not apply when slurry mixture is applied by hand lutes such as for slurry leveling.

10. Maximum of 2.5% passing the 75 µm sieve allowed for crushed limestone or dolomite when documented production is 1% or less.

11. When Producer gradation test results are used for acceptance, test results representing at least 90% of the material being produced shall be within the gradation limits and the average of all gradation results shall be within the gradations limits. Stockpiled material not meeting the criteria may, at the District Materials Engineer's discretion, be resampled using Materials I.M. 301 procedures. One hundred percent of the stockpile quality control and verification test results shall be within the gradation limits.

THEORETICAL RATE OF EVAPORATION CHART (English Units)

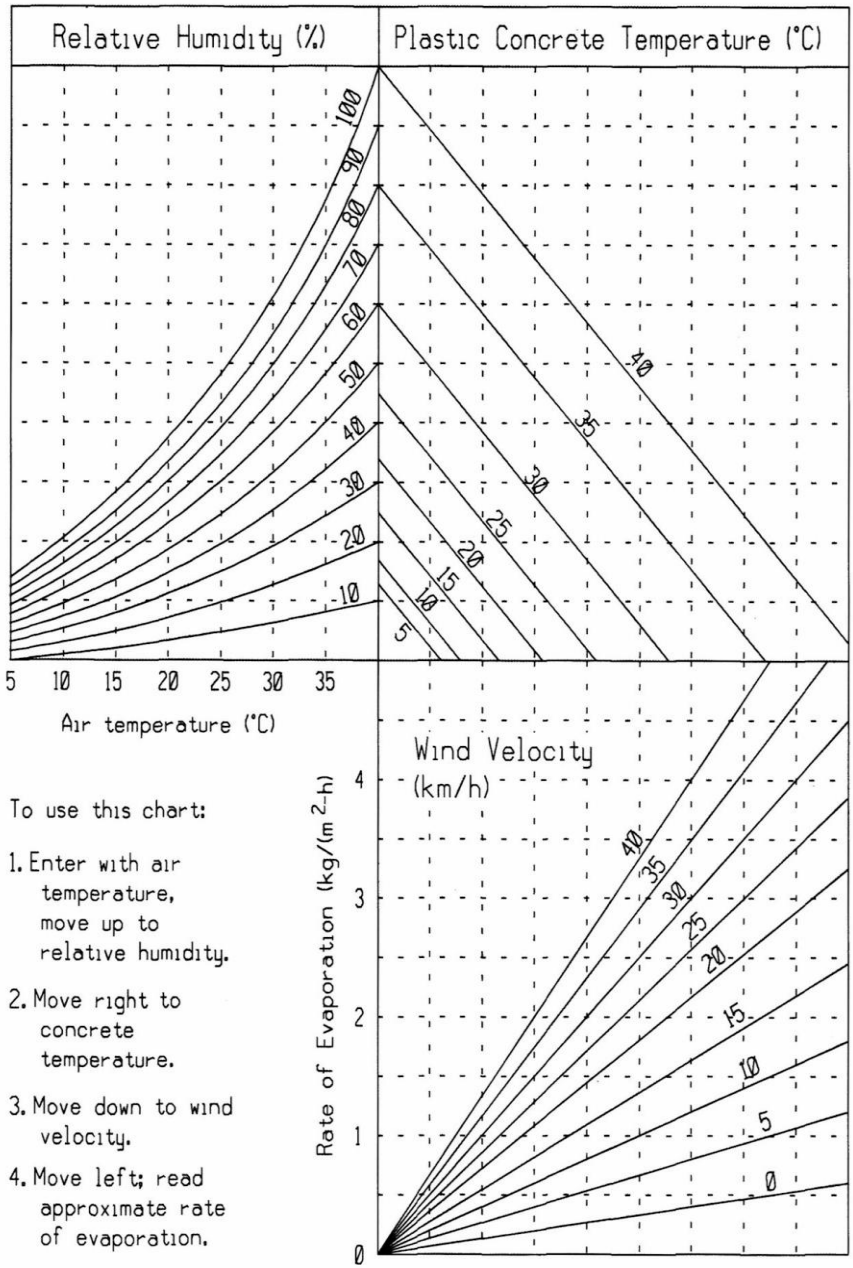


To use this chart:

1. Enter with air temperature, move up to relative humidity.
2. Move right to concrete temperature.
3. Move down to wind velocity.
4. Move left; read approximate rate of evaporation.

APPENDIX

THEORETICAL RATE OF EVAPORATION CHART (Metric Units)



To use this chart:

1. Enter with air temperature, move up to relative humidity.
2. Move right to concrete temperature.
3. Move down to wind velocity.
4. Move left; read approximate rate of evaporation.