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Concreting in Colder weather

Ballarat is one of the areas in Victoria, Australia, the temperature ranges experienced in winter can present problems with the concrete placement that need to be managed. Table 2 shows the weather in Ballarat area in June. This document herein provides information on properties of concrete during colder months.

Cement hydration is a chemical reaction that generates heat. Newly placed concrete should have adequate heat for concrete to have continual hydration process.

Low concrete temperature has a number of effects on the rate of cement hydration which result in slower setting and rate of strength.

- The lower rate of cement hydration at low temperatures increases the setting times. Table 1 shows the approximate setting time of concrete with different temperatures.
 - Slower setting time increases the time for bleed water to evaporate from the concrete surface.

Table 1: Variation of setting time with air temperature

Temperature (⁰ C)	Approximate setting time (hours)
38	1-3
32	2-3
27	4
21	6
16	8
10	11
4	14
-1	19
-7	Setting will not occur

- Slower strength gain: At lower temperatures the gain in concrete strength is considerably slower than at normal temperatures. Figure 1 shows the development of compressive strength at different temperatures.

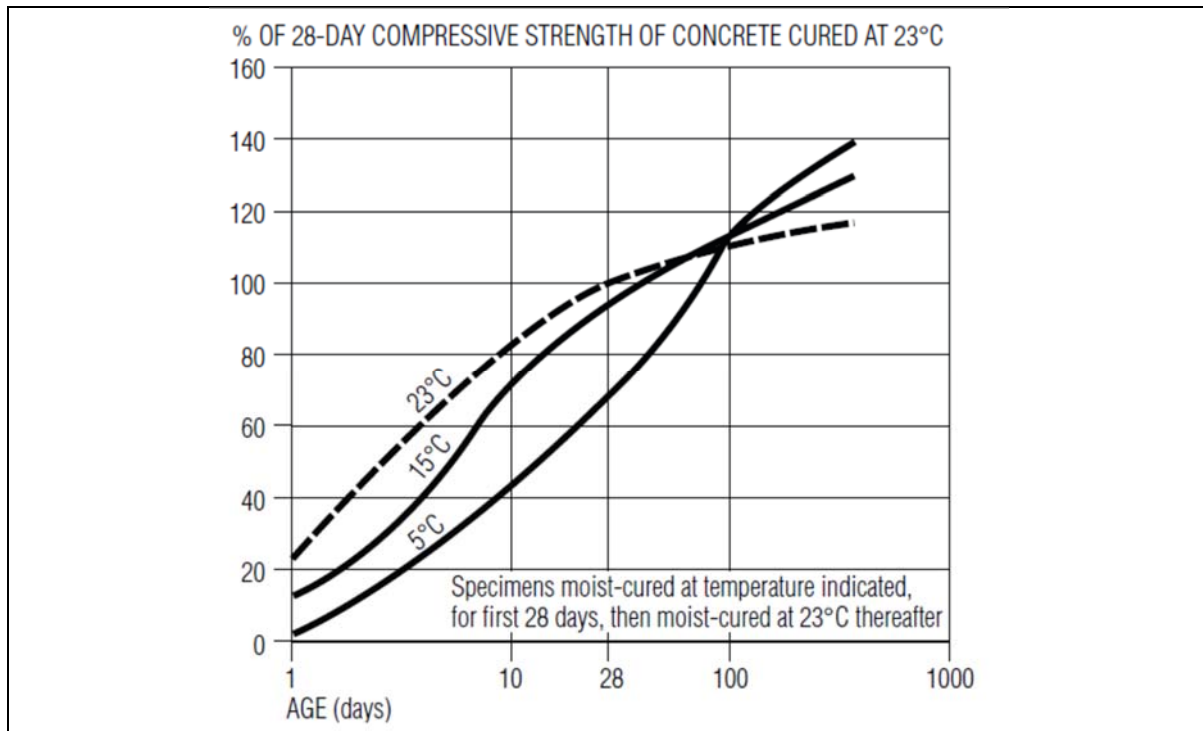


Figure 1: Compressive strength development in concrete in colder weather

A number of these problems can be overcome through the addition of admixtures to concrete.

- Accelerating admixtures can help offset the effects of low temperatures by increasing the rate of cement hydration. This aids in the concrete setting time and the development of early strength in the concrete. Dose rates of accelerator vary depending on the ambient temperature at the job site.
- Entrained air greatly improves concrete freeze/thaw resistance to damage. The addition of an air entraining agent causes millions of extremely small air bubbles to be introduced into the concrete matrix. This 'entrained' air remains in the concrete where the larger, naturally 'entrapped' air will make its way to the concrete surface during normal placing operations. Because ice occupies a much larger volume than its original liquid, it exerts great pressures within the concrete which can damage the cement paste. Repeated cycles of freezing and thawing will eventually lead to a deterioration by providing extra space for the pressure to be dispersed over. Air entrainment also leads to increased workability and general durability of the concrete.



Table 2: Weather and climate in Ballarat area during month June (Data sourced <http://www.bom.gov.au/climate/dwo/IDCJDW3005.latest.shtml>)

Date	Jun-20																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Minimum temperature (°C)	4.4	4.2	6.8	1	0.4	-1.3	4.5	1.2	-3.5	1.1	-2.4	-0.3	4.9	3.8	6.6	9.1	4.5	0.2
Maximum temperature (°C)	7.3	10.9	10.7	13	11.7	10.9	8.7	9.8	10	12.5	13.7	11	13.3	11.5	13.5	13.6	9.9	
Rainfall (mm)	7	5.4	1	0.2	0.2	0	0.8	0.2	0	0.2	0	0	0	1.8	2.6	0	1.6	0
Direction of maximum wind gust	N	W	SSE	SE	NW	SSE	SE	S	N	N	NW	NNE	NNE	NNW	NNW	WNW	SSE	
Speed of maximum wind gust (km/h)	54	41	46	30	20	31	33	26	35	33	17	52	59	48	46	48	17	
Time of maximum wind gust	1:23	14:15	11:28	10:03	12:22	21:39	13:59	10:21	11:14	10:05	14:56	23:02	0:03	13:09	14:03	12:36	3:18	
9am Temperature (°C)	4.9	7.2	7	5.1	4.2	6.2	5.3	3.7	2.8	4.7	3.6	6.3	9.6	6.7	11	10.6	7.3	3.7
9am relative humidity (%)	99	100	98	99	100	100	98	100	100	100	100	100	98	99	100	100	100	99
9am cloud amount (oktas)	8	8	8			8	8	7		8	4		8	1	8	8	7	4
9am wind direction	W	W	S	S	N		S	S	N	NNW	ESE	NE	NNE	N	NNW	N		NNW
9am wind speed (km/h)	31	17	19	9	4	Calm	15	13	6	15	6	11	31	17	22	26	Calm	19
9am MSL pressure (hPa)	1006	1020	1030	1035	1031	1027	1027	1032	1033	1029	1027	1025	1016	1014	1019	1021	1034	1035
3pm Temperature (°C)	5.6	10	10	12.7	11.4	10.2	8.2	9.1	9.4	12.3	13.5	10.4	12.7	10.6	12.7	11.5	9.2	12
3pm relative humidity (%)	100	99	69	55	67	76	73	74	76	66	45	70	78	89	98	86	66	84
3pm cloud amount (oktas)	8	8	1		2	8	8	1	4				6	8	8	8	8	1
3pm wind direction	WSW	W	S	SSE	W	SSW	SSE	SSE	N	NNW	WNW	N	NNE	NNW	NNW	W	E	N
3pm wind speed (km/h)	30	22	28	9	13	6	22	19	20	13	13	24	37	31	30	31	6	37
3pm MSL pressure (hPa)	1010	1020	1032	1032.3	1029	1025	1026	1031	1031	1026	1025	1022	1010	1014	1018	1022	1034	1030