CONCRETE INFORMATION
PORTLAND CEMENT ASSOCIATION
STRUCTURAL BUREAU

Prevention of Plastic Cracking in Concrete

CRACKING that occurs in the surface of fresh concrete soon after it has been placed and while it is still plastic is called "plastic cracking." The cracks appear mostly on horizontal surfaces and may be practically eliminated if appropriate measures are taken during construction to minimize the causes.

Field investigations indicate that the principal cause of plastic cracking is rapid drying of the concrete at the surface. Even when the same materials, proportions and methods of mixing, handling, finishing and curing are used, cracks may develop one day but not the next. This is usually due to a change in weather conditions that increases the rate of evaporation from the surface of the fresh concrete. If this exceeds the rate at which water rises to the surface then plastic cracking is likely to occur.

RATE OF BLEEDING

After concrete is placed, the aggregate and cement start to settle and water rises or "bleeds" to the surface. The rate at which this water reaches the surface and the total quantity which accumulates depends on the depth of concrete, on materials used, mix proportions and temperature. The deeper the concrete, the more water likely to rise to the surface. When a high cement content and fine aggregate are used and when water content and slump are reduced, bleeding decreases. It also decreases with a rise in concrete temperature. Loss of water into dry aggregates, a dry subgrade or dry forms further reduces bleeding.

RATE OF EVAPORATION

The rate of evaporation is influenced by the relative humidity, concrete and air temperatures and wind velocity. Even relatively small changes in these atmospheric conditions may have a pronounced effect on the rate of evaporation, especially if they occur simultaneously.

For example, when the relative humidity changes from 90 to 50 per cent (see table, part 2), the rate of evaporation is increased five times; if further reduced to 10 per cent, evaporation is increased nine times.

When both concrete and air temperatures increase from 50 to 70 deg. F. (table, part 3) evaporation is doubled; if further increased to 90 deg. F., evaporation is increased four times.

With an air temperature of 40 deg. F. the rate of evaporation is tripled when the concrete temperature is raised from 60 to 80 deg. F. (table, part 5).

The rate of evaporation is four times greater when the wind velocity increases from zero to 10 mph, (table, part 1), and is nine times greater when the wind velocity further increases to 25 mph.

It is apparent, then, that the rate of evaporation is highest when the relative humidity is low, when concrete and air temperatures are high, when the concrete temperature is higher than the air temperature and when the wind is blowing over the concrete surface. The combination of hot, dry weather and high winds often prevailing during summer months removes moisture from the surface faster than it can be replaced by normal bleeding; but even in cold weather rapid drying is possible if the temperature of concrete when placed is high compared to the air temperature.

METHODS OF PREVENTION

A few simple precautions can be taken to minimize the causes of plastic cracking. They should be considered in planning the construction procedures for a job or in dealing with the problem if it occurs after construction is started. Some helpful precautions are listed below: These are not listed in order of importance but more nearly in the order in which they occur in construction.

1. Dampen the subgrade and forms.
2. Dampen the aggregates if they are dry and absorptive.
3. Erect windbreaks to reduce wind velocity over the concrete surface.
4. Provide sunshades to control surface temperature of the concrete.
5. Avoid excessive temperature differences between concrete and air.
6. Lower the concrete temperature in hot weather.
7. Avoid overheating the concrete in cold weather.
8. Protect the concrete with temporary coverings during any appreciable delay between placing and finishing.
9. Reduce time between placing and start of curing by improved construction procedures.
10. Protection of the concrete the first few hours after placing and finishing to minimize evaporation is most important to avoid checking and cracking. Application of moisture to the surface, using a fog spray nozzle, is an effective means of preventing evaporation from the concrete. This should be used until a suitable curing material can be applied to the surface such as a white membrane curing compound, wet burlap or sand, light-colored paper or other coverings which will prevent evaporation.

Effect of Variations in Concrete and Air Temperatures, Relative Humidity and Wind Speed on Drying Tendency of Air at Job Site

Case No.	Concrete Temp., °F	Air Temp., °F	Relative Humidity, %	Dew Point, °F	Wind Speed	Drying Tendency lb./sq.ft./hr.
(1) Increase in Wind Speed						
1	70	70	70	59	0	.015
2	70	70	70	59	5	.038
3	70	70	70	59	10	.062
4	70	70	70	59	15	.085
5	70	70	70	59	20	.110
6	70	70	70	59	25	.135
(2) Decrease in Relative Humidity						
7	70	70	90	67	10	.020
8	70	70	70	59	10	.062
9	70	70	50	50	10	.100
10	70	70	30	37	10	.135
11	70	70	10	13	10	.175
(3) Increase in Concrete and Air Temperatures						
12	50	50	70	41	10	.026
13	60	60	70	50	10	.043
14	70	70	70	59	10	.062
15	80	80	70	70	10	.077
16	90	90	70	79	10	.110
17	100	100	70	88	10	.180
(4) Concrete at 70° F; Decrease in Air Temperature						
18	70	80	70	70	10	.000
19	70	70	70	59	10	.062
20	70	50	70	41	10	.125
21	70	30	70	21	10	.165
(5) Concrete at High Temp.; Air at 40° F and 100% R. H.						
22	80	40	100	40	10	.205
23	70	40	100	40	10	.130
24	60	40	100	40	10	.075
(6) Concrete at High Temp.; Air at 40° F; Variable Wind						
25	70	40	50	23	0	.035
26	70	40	50	23	10	.162
27	70	40	50	23	25	.357
(7) Decrease in Concrete Temp.; Air at 70° F						
28	80	70	50	50	10	.175
29	70	70	50	50	10	.100
30	60	70	50	50	10	.045
(8) Concrete and Air at High Temp.; 10% R. H.; Variable Wind						
31	90	90	10	26	0	.070
32	90	90	10	26	10	.336
33	90	90	10	26	25	.740

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