Case Study Topic: ***How late can the sawing operations be scheduled? Can initial sawing be performed at every other joint without causing thermal cracks to occur?***

BACKGROUND

When sawcutting the joints in a concrete pavement, two critical factors are considered:

1) earliest saw cutting time, and
2) latest saw cutting time.

If joints are cut too early, the strength gained by the concrete may be not enough to support the saw cutting equipment, and structural damage to the pavement may occur. In addition, saw cutting operations may cause raveling along the joint which may progress into significant spalling damage. If joints are not cut before the magnitude of tensile stress exceeds the concrete strength, uncontrolled random cracking may occur in the pavement. Both, slab spalling and random cracking distresses are an undesirable situation that affect the performance of the pavement and significantly reduce its service life.

In this case study, the latest time for joint sawing is analyzed with HIPERPAV. Also, the possibility of temporarily skipping designated joint cuts to minimize the risk of cracking for a large paving placement is analyzed and the risks are evaluated.

For this case study, three scenarios are evaluated for a 10" jointed concrete pavement. Air temperature drop from day to night is selected as the variable factor for the three scenarios:

Scenario 1: Temperature drop 90–55° F (Desert)
Scenario 2: Temperature drop 85–55° F (Mid-west)
Scenario 3: Temperature drop 62–57° F (Gulf coast)

ANALYSIS STRATEGY

The saw cutting time before significant stresses develop should be selected carefully making sure that no significant risks arise from delay of the sawing operations. It is thus critical to monitor climatic conditions for abrupt changes that may change the stress condition in the pavement.

Due to the expensive risks that late saw cutting implies, a high reliability is recommended when performing this type of analysis. A 95% reliability is selected for this case.

The recommendations for latest sawing time for each scenario are presented based on the HIPERPAV analysis.

By doubling the transverse joint spacing in the design input section of HIPERPAV the risks of saw cutting at every other joint (skip sawing) are evaluated for every scenario.

SOLUTION

The results of the analysis for the three climatic scenarios are presented in Tables 1, 2 and 3.

Table 1: Analysis for Scenario #1

Saw cutting age	Critical Strength (psi)	Critical Stress (psi)	Critical Strength/ Stress	Time at critical f_t/σ
9 h	184	167	1.10	Max at 18 hrs
12 h	184	167	1.10	Max at 18 hrs
15 h	140	130	1.08	Max. at 14 hrs
18 h	173	236	0.73	Max. at 17 hrs

Table 1 shows the results of the analysis in terms of the critical strength to stress ratio. A strength to stress ratio lower than one indicates that excessive stresses occur. In this case the results suggest performing the sawing operations before 12 hours after placement.

The analysis for skip sawing was performed for the above scenario with joint sawing at 12 hours after placement and considering twice the design joint spacing. The results indicate that the stress equals the concrete strength at 18 hours. This situation represents high risks of thermal cracking. Therefore, skip sawing is not a feasible solution for this case.

Table 2: Analysis for Scenario #2

Saw cutting age	Strength	Stress	Max. Strength/Stress	Time at maximum stresses
9	181	148	1.22	Max at 18 hrs
12	181	148	1.22	Max at 18 hrs
15	140	127	1.10	Max. at 14 hrs
18	170	215	0.79	Max. at 15 hrs

From Table 2, the results of the analysis for the second scenario suggest to perform the joint sawing operations before 18 hours. By sawing every other joint before 12 hours after placement, a maximum strength to stress ratio of 1.12 was obtained. For this case, skip sawing is a viable alternative. Therefore, the skipped joints could be sawed at a later time without representing a risk to the structure.

Again, it should be emphasized that weather conditions would have to be closely monitored to avoid problems.

For scenario #3, a lower concrete mix temperature and subbase temperature are expected. It is observed that the sawcutting of the pavement can be postponed up to 36 hours without considerable risks to the structure. Skip sawing can also be accomplished with no significant risk.

Table 3: Analysis for Scenario #3

Saw cutting age	Strength	Stress	Max. Strength/Stress	Time at maximum stresses
9	218	88	2.48	Max. at 25 hrs.
12	218	88	2.48	Max. at 25 hrs
18	156	112	1.36	Max. at 17 hrs.
24	166	128	1.30	Max. at 18 hrs.
30	166	128	1.30	Max. at 18 hrs.
36	267	246	1.09	Max. at 36 hrs.
40	277	316	0.88	Max at 40 hrs.

In summary, the results from this case study demonstrate that for the first scenario, with a high temperature drop, joint sawing should be performed before 12 hrs. Saw cutting every other joint for this case is not recommended.

For the second scenario, with a moderate temperature drop, the concrete has to be sawed before 18 hrs although for this case, temporarily skip sawing is possible.

For low temperature drops (mild climates), late sawcutting and skip sawing joints are both possible given the low ambient temperature drop expected.