GROUP F

OTHER FRACTURE

Chairman, E. B. Wilkins; members, Milton E. Harr, Richard A. McComb, Wolfgang G. Knauss, Phillip L. Melville, Eugene L. Skok, Jr., Bernard A. Vallerga, and Russell A. Westmann

The basic purpose of this session was to assess the current state of knowledge and available design methodology relating to "other" (non-traffic-load associated) fracture of flexible pavements. A subsequent purpose was to identify the deficiencies in this methodology and to recommend both short- and long-term research and development needs.

It was agreed initially that the forms of other fracture that are of concern are:

1. Shrinkage cracking (i. e., that associated with thermal cycling, aging, aggregate absorption, and moisture changes);
2. Thermal contraction cracking;
3. Reflection cracking (i. e., existing cracks reflecting up through overlays or surface treatments);
4. Foundation-associated cracking (i. e., settlement, heave, and freezing shrinkage); and
5. Construction-associated cracking (i. e., overrolling) in asphaltic concrete surfacing.

It was further agreed that the type of other fracture that was of concern was that which manifested itself in cracking of the surface.

Finally, Group F agreed to concentrate its deliberations on items 1, 2, and 3 for several reasons: (a) There was a greater possibility of short-term solutions for these three, and (b) it appeared more logical to consider the situations where fracture is in itself the primary mechanism. (See the Group H report for a discussion of item 3.)

The following conclusions were reached by Group F. (See Table 1 for recommendations.)

1. Other fracture can occur or be initiated in any component of the pavement. However, the most prevalent is one that is initiated in the bituminous surface, except for the case of reflection cracking.
2. The effects of other fracture do not usually initially impair serviceability. However, because of moisture intrusion, loss of load transfer, and the like, accelerated deterioration can occur. Moreover, cracking is unsightly to the traveling public, the effect often being accentuated by poor maintenance practice, and indicates certain deficiencies in the structure. The combined effects often result in premature resurfacing and additional costs.
3. Shrinkage or thermal contraction cracking or both are prevalent to varying degrees throughout most of the United States and Canada. However, the causes can vary from region to region and are not always readily apparent. For example, in northern areas extreme low temperatures have been shown as the dominant cause. In southern areas asphalt aging combined with termal cycling may be important, although conclusive proof for this does not exist.
4. A working subsystem (1) to eliminate or to predict the occurrence of thermal contraction cracking in new pavements is available. This is based on extensive field (including several road tests) and laboratory investigations.

TABLE 1

RECOMMENDATIONS FOR RESEARCH

Recommendation	Ranking	State of Art	Priority	
			Short Range	Long Range
Develop a mechanistic model of "reflection cracking" for (a) non-load-associated conditions and (b) stress-strain conditions	1	Model needed	1	1
Evaluate limiting stress guides to control thermal contraction cracking for a wider range of environments (i.e., refine)	2	Model available	—	1
Develop a prediction model having cracking index as dependent variable for various regions by using regression methods and available data	3	Some regressions available	2	2
Develop predictive procedure for subgrade-initiated shrinkage cracking (i.e., due to freezing shrinkage)	4	Some work in Alberta		3
Evaluate thermal cycling combined with aging effects on shrinkage factors	5	Model needed	—	3
Evaluate effects of varying maintenance strategies for non-load cracking in relation to serviceability	6	Some rough data available (CGRA)	X	X

5. The main component of the pavement considered in the working subsystem is the bituminous one. It is best characterized by stiffness (van der Poel definition). The method of determining stiffness can be either direct (Haas and Anderson methods) or indirect (Shell method). Additional work is required to correlate the two methods for bituminous materials in America to supplement the Shell research in Europe.

6. Reflection cracking is a serious problem (or will be in many areas unless better design and control methods are developed) in many parts of the United States and Canada because of the many miles of existing cracked pavements. Reflection cracking can be delayed (up to 2, 3, or more years) by "sandwiched" granular layers or by thick overlays, but it is difficult to eliminate. It must be recognized, though, that reflection cracking may in many cases be primarily load-associated.

7. Thermal contraction cracking occurs in Canada when the stiffness modulus of the surfacing exceeds approximately 2×10^6 psi at the lowest temperature occurring in the surfacing. This corresponds to a stiffness of approximately 3×10^4 psi for the bitumen used in a dense-graded paving mixture compacted to 3 percent air voids. At this stage little is known concerning the prediction of low-temperature stiffness variations during the aging process.

The group suggests as a guide the following working system of limiting stiffness:

Minimum Expected Temperature (deg F)	Stiffness Modulus (psi)	
	Cracking Expected	Cracking Eliminated
-40	1,000,000	500,000
-25	700,000	300,000
-10	400,000	200,000
+10	100,000	50,000

REFERENCE

1. Haas, R., et al. Low Temperature Pavement Cracking in Canada: The Problem and Its Treatment. CGRA, 1970.