TABLE 12 STUDY OF PAVING REINFORCEMENT MICHIGAN STATE HIGHWAY DEPARTMENT—F A 68 DEF

Table Showing Relation of Slab Length to Number of Corner Breaks per Station Breaks Due to Edge Bar Uniform 8-inch with Center Joint

Single ¾" Edge Bar

Slab Lengths	0–40	40–100	100–150	150–200	200–250	250–300	300–350	350–400	400–450	450–500	Over 500
Average Slab Length	33	84	128	200	228	277	320	380	423	482	586
No Slabs	1	4	2	1	10	8	7	4	6	12	24
No Breaks	0	0	0	0	2	7	6	4	2	17	38
Breaks per Slab	0	0	0	0	0 2	0 9	0 9	1 0	1 5	1 4	1 6

Double ¾" Edge Bar

Average Slab Length	18	61	128	169	224	277	0	0	402	475	609
No Slabs	6	7	5	6	9	8	0	0	1	3	1
No Breaks	0	0	1	0	2	2	0	0	0	12	7
Breaks per Slab	0	0	0 2	0	0 2	0 25	0	0	0	4 0	7 0

C Plain concrete pavement, 6-8-6 section, 16 feet wide. 32 miles long, similar subgrade and age, but with 50 per cent more traffic than *A* and *B*—$24 30

D Plain concrete pavement, 6-8-6 section, 18 to 20 feet wide and 15 miles long, with less favorable subgrade and 3 to 5 times the traffic of roads *A* and *B*—$78 50

Since at $1,000 per mile cost for reinforcement a saving of $70 95 would be required to warrant its use it would seem that unless it afforded a reduction in first cost of road, reinforcement would not be economically justified for average soil, traffic and climatic conditions existing in Delaware

EFFECT OF REINFORCEMENT AS SHOWN BY COLUMBIA PIKE EXPERIMENTAL ROAD

SUMMARY OF REPORT

BY J T PAULS

U S Bureau of Public Roads, Washington D C

Based on comparative sections, gravel aggregate, with and without center joint, 200 feet long and 4 years old, the following conclusions are offered

1 Combined longitudinal and transverse crack in full width sections was reduced more consistently with slab thickness than was either one separately

2 Plain half width sections contained no more transverse cracks than did full width sections

3 Mesh reinforced sections contained considerably less crack than plain sections Six-inch section with mesh reinforcement contained about the same crack length as an 8-inch plain slab Six-inch sec-

tion, with 50-lb mesh reinforcement, showed less crack than the section containing 25-lb mesh

4 Bonded longitudinal reinforcement of less tensile strength than that of the concrete (25-mesh, 50-lb mesh, four ½″ rods and four ¾″ rods) was more or less ruptured at open transverse cracks, but did not cause corner breaks or fine transverse cracks in the slabs

5 Large amounts of longitudinal steel in bond (8 ¾-inch bars) caused excessive transverse cracking and corner cracks

6 Transverse steel across longitudinal joints held the slabs together and prevented spalling

7 Sections with ⅜″ transverse rods contained more transverse cracks than sections reinforced only longitudinally A further increase in cracks resulted when ½″ transverse rods were used, the cracks in each case being directly over the bars

These conclusions are supported by Figures 90 and 93 and the chart, Figure 94, showing relative conditions of sections based on 2,000 sq yds of surface area

The impracticability of having bonded longitudinal steel function in long slabs is shown by the following analysis and demonstrated by Figure 90

The subgrade resistance to pavement contraction in longitudinally reinforced pavements after being carried across transverse cracks by the steel is transferred to the concrete at a rate depending on bond and strength of concrete

If the bond at any point along the bar exceeds the tensile strength of the concrete, a crack must necessarily occur But if the tensile resistance of the concrete exceeds the accumulated bond at any point, a slipping or breaking of the steel will occur near the transverse crack

If bars are grouped along the edges, the resulting small concrete section involved with accompanying lack of tensile strength promotes the formation of corner breaks When bars are distributed over the full width of the section, the accompanying breaking force is also distributed and causes transverse rather than corner cracks These fine intermediary cracks noted in the sections having a large amount of distributed steel are additional to cracks caused by the subgrade resistance

Often one or more breaks have occurred back of the first corner crack and these were probably caused by a repetition of the forces responsible for the first crack and these additional cracks can be expected until the tensile strength of the concrete becomes greater than the total bond strength

This type of corner crack generally extends from the edge of the pavement transversely about half the spacing distance beyond the inner bar, and then diagonally toward the transverse crack The minimum concrete section which resists corner cracking seems to be the transverse portion of the break, which section remains constant for a distance from the transverse crack equal to the length of this minimum section Beyond this position, the length of the effective portion of concrete in a corner probably increases directly as the distance from the transverse crack

The application of this assumption is demonstrated in Figure 90, which shows the number of corner cracks computed from this analysis, compared with the number which actually occurred

In Sections 18 and 19, with one ½" and one ¾" bars, respectively, along the edge and center joints, the tensile strength of the concrete increased faster than did the bond strength and would therefore not be expected to have many corner cracks, and inspection showed they did not In Sections 20, 23, 24, 26 and 27, with larger amounts of concentrated reinforcing bond strength increased faster than tensile strength in the concrete and therefore many corner breaks could be expected As shown by inspection of these sections, this expectation was realized

Round deformed bars were used in these sections Bars more highly deformed than these and those having attached shear lugs, thus having higher bond strength, would probably cause more corner breaking

It is emphasized that this discussion of longitudinal reinforcing applies only to steel bonded for long distances and detracts in no way from the beneficial effects of properly used bar reinforcement

U S BUREAU OF PUBLIC ROADS IMPACT TESTS

SUMMARY OF REPORT

By E B Smith and L W Teller

U S Bureau of Public Roads, Washington, D C

On both wet and dry subgrade, additional concrete thickness afforded considerably increased resistance of 7 x 7 foot slabs to impact blows delivered both at corners and sides

On dry subgrade neither mesh reinforcement nor bar mats offered appreciable increase in resistance of slab corners to impact blows

While the rod-reinforced slabs sustained somewhat heavier blows than the unreinforced slabs, they were made from more resistant concrete and if correction is made for this factor, little additional resistance would be shown by the reinforced specimens over that of the plain ones

On wet subgrade mesh-reinforced slabs were more resistant to impact blows than the plain concrete specimens