Performance Of Interlocking Concrete Pavements in North America

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Abstract — Interlocking concrete pavements are increasingly being used in North America for roadway and urban infrastructure applications. However, limited information has been available regarding their long-term performance under North American traffic and environmental conditions. This study evaluates the performance of interlocking concrete pavements at three sites located in North Bay and Timmins, Ontario, Canada, and Fayetteville, North Carolina, USA. The investigation included field evaluations such as nondestructive deflection testing, visual distress surveys, and transverse profile measurements for rut depth analysis. Results indicated that interlocking concrete pavements exhibit structural behavior similar to flexible pavements and provide excellent long-term performance with minimal distress and low rut depths after 6–8 years of service. The study also confirmed that traffic loading significantly influences the stiffness of the paver-sand composite layer due to progressive interlocking action.

Keywords: Interlocking Concrete Pavements; Pavement Performance Evaluation; Flexible Pavement Behavior; Rut Depth Analysis; Nondestructive Deflection Testing; Long-Term Pavement Performance;

I. Introduction

The concept of interlocking concrete pavements originated in Europe and has been extensively used for both pedestrian and vehicular applications. In North America, the adoption of interlocking concrete pavements began during the mid-1970s. Their popularity has steadily increased because of their aesthetic appeal, structural capacity, durability, and ease of maintenance.

Despite their growing application, limited field performance data have been available to verify and calibrate existing pavement design methods under North American climatic and traffic conditions. Therefore, this research was undertaken to evaluate the structural and functional performance of selected interlocking concrete pavement projects.

The primary objectives of the study were:

- To evaluate the structural capacity of interlocking concrete pavements,
- To assess pavement distress and rutting performance,
- To compare pavement behavior with conventional flexible pavements, and
- To identify major factors affecting pavement performance.

II. Description of Study Sites

Three interlocking concrete pavement projects were selected for detailed evaluation.

A. North Bay, Ontario

The North Bay project involved the reconstruction of Main Street using interlocking concrete pavements as part of a downtown renovation program. The pavement structure consisted of:

- 80 mm concrete pavers,
- 30 mm bedding sand,
- 150 mm granular base, and
- 200 mm granular subbase.

The pavement was subjected to approximately 8,000 vehicles per day and severe freeze-thaw climatic conditions.

B. Timmins, Ontario

The Timmins downtown renovation project utilized interlocking concrete pavements over multiple streets. The pavement structure included:

- 80 mm concrete pavers,
- 30 mm bedding sand, and
- 150 mm granular base.

The area experiences extremely harsh winter conditions and receives significant snowfall annually.

C. Fayetteville, North Carolina

The Hay Street Transit Mall in Fayetteville was designed primarily for bus traffic. The pavement structure consisted of:

- 80 mm concrete pavers,
- 38 mm bedding sand,
- 50 mm asphalt concrete layer, and
- 200 mm granular base.

Compared with the Canadian sites, Fayetteville experiences a milder climate with less severe winter conditions.

III. Methodology

The performance evaluation included the following investigations:

A. Deflection Testing

A Falling Weight Deflectometer (FWD) was used to assess pavement structural capacity. Deflection basin measurements were obtained under applied impulse loads ranging from 22 kN to 40 kN.

B. Visual Distress Surveys

Visual condition surveys were conducted to identify and quantify pavement distress types including:

- Rutting,
- Surface depressions,
- Block spalling,
- Cracked blocks,
- Joint deformation, and
- Snowplow damage.

C. Rut Depth Measurements

Transverse profile surveys were conducted using a Dipstick Auto-Read Profiler to determine pavement rut depths and surface deformation characteristics.

D. Backcalculation Analysis

Layer elastic moduli were backcalculated using multilayer elastic analysis software. The paver blocks and bedding sand were modeled as a composite surface layer.

IV. Results and Discussion

A. Structural Capacity

The study showed that the modulus of the composite paver-sand layer increased with traffic loading. Higher traffic volumes enhanced the interlocking action between individual pavers, resulting in increased structural stiffness.

The back calculated moduli for heavily trafficked areas ranged between 420 ksi and 560 ksi, which were comparable to conventional asphalt concrete pavements.

These findings confirmed that interlocking concrete pavements behave similarly to flexible pavements once adequate interlock has developed.

B. Pavement Distress

Visual surveys indicated that the pavements remained in excellent condition after several years of service. Most observed distress was localized and primarily associated with:

- Utility repair areas,
- Snow removal operations,
- Inferior-quality pavers, and
- Localized drainage problems.

The most common distress types included:

- Corner and edge spalling,
- Surface depressions,
- Snowplow damage, and
- Surface staining.

However, the total distressed area was generally less than 1.5% of the pavement surface.

C. Rutting Performance

Measured rut depths were relatively small at all sites.
Average rut depths were:

- 0.22 inches in North Bay,
- 0.33 inches in Timmins, and
- 0.11 inches in Fayetteville.

These values were significantly below commonly accepted pavement failure limits of 0.50–0.75 inches.

The study also observed that rut depths in the right wheel path were generally greater than those in the left wheel path, likely due to reduced edge confinement during construction.

V. Conclusions

Based on the analysis and interpretation of the collected data, the following conclusions were drawn:

1) Interlocking concrete pavements exhibit structural behavior similar to flexible pavements.
2) The stiffness of the paver-sand composite layer increases with traffic loading due to progressive interlocking action.
3) The evaluated pavements demonstrated excellent long-term performance after 6–8 years of service.
4) Pavement distress was minimal and generally localized.
5) Rut depths remained well below failure criteria at all study sites.
6) Proper construction practices, edge restraints, and bedding sand quality are essential for satisfactory pavement performance.
7) Additional long-term monitoring studies are recommended to further evaluate the influence of traffic, climate, and construction variables on pavement behavior.

References

[1] Rada, G. R., Stephanos, P. J., & Tayabji, S. D. *Performance of Interlocking Concrete Pavements in North America*. Transportation Research Record 1388, Transportation Research Board, National Research Council, Washington, D.C., 1993.

[2] Shahin, M. Y., & Kohn, S. D. *Pavement Maintenance Management for Roads and Parking Lots*. U.S. Army Construction Engineering Research Laboratory, 1981.

[3] Sharp, K. G., & Armstrong, P. J. *Testing of Concrete Block Pavements by the Australian Road Research Board*. Proceedings of the 2nd International Conference on Concrete Block Paving, 1984.

[4] Shackel, B. *The Design of Interlocking Concrete Block Pavements for Road Traffic*. Proceedings of the 1st International Conference on Concrete Block Paving, 1982.