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Review Article

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# Adding Segment Weights to a Standardized Pavement Inspection System

**Paul T E Cusack***

*BScE (Civil), Canada*

*Corresponding Author
Paul T E Cusack, BScE (Civil), Canada

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***Abstract***

*A previous paper introduced the Standardized Grade Point Average (sGPA) framework for evaluating urban pavement systems by assigning academic-style grades to pavement condition. While the framework provided a consistent scoring methodology, it implicitly assumed that all inspected pavement segments contribute equally to the overall network grade. In reality, roadway segments vary greatly in importance according to their size and traffic demand. This paper proposes a weighting factor based on roadway geometry and traffic volume so that heavily travelled arterial roads contribute more to the overall pavement sGPA than lightly travelled residential streets. The refinement more accurately reflects network performance and infrastructure priorities while maintaining the simplicity of the original grading system.*

**Keywords:** Pavement Management, Infrastructure Economics, Pavement Condition Index, GIS, Weighted Average, Road Inspection, Transportation Engineering

## 1. Introduction

The standardized GPA (sGPA) pavement inspection system previously proposed by Cusack (2026) provides a simple and intuitive method of summarizing the condition of an urban road network. Each pavement segment receives a letter grade corresponding to its condition. One limitation of the original methodology is that every inspected segment contributes equally to the final sGPA regardless of its relative importance. A short residential street therefore influences the network score as much as a major arterial carrying tens of thousands of vehicles daily.

This paper introduces a weighting factor that accounts for both roadway size and traffic demand.

### 1.1. Segment Weight

The proposed segment weight is

$$Ws = L_n \times L \times T$$

where

- $L_n$ = number of traffic lanes
- $L$ = segment length (km)
- $T$ = traffic volume category

Traffic volume categories are defined as

| Category | Average Daily Traffic / Equivalent |
|---|---|
| 1 | up to 10,000 vehicles |
| 2 | 10,001–20,000 |
| 3 | 20,001–30,000 |
| 4 | greater than 30,000 |

**Table 1**

Typical roadway lengths may be
- 0.2 km
- 0.4 km
- 0.6 km
- 0.8 km
- km

Typical lane counts
- 2 lanes
- 3 lanes
- 4 lanes
- 5 lanes
- 6 lanes

Thus,

Segment Weight = (Lanes)(Length)(Traffic Category)

### 1.2. Pavement Grade

The pavement condition score remains unchanged from the original paper

| Letter Grade | Numerical Value |
|---|---|
| A | 4.0 |
| A− | 3.7 |
| B+ | 3.3 |
| B | 3.0 |
| B− | 2.7 |
| C+ | 2.3 |
| C | 2.0 |
| C− | 1.7 |
| D | 1.0 |
| F | 0.0 |

**Table 2**

### 1.3. Weighted Contribution

Each pavement segment contributes

$C_i = W_i \times RCS_i$

where
- $W_i$ = segment weight
- $RCS_i$ = road condition score

The total network score becomes

$$\sum_{i=1}^{n} W_i \, RCS_i$$

### 1.4. Network sGPA

The weighted pavement GPA is then

$$sGPA = \frac{\sum W_i \, RCS_i}{\sum W_i}$$

This weighted-average formulation is preferable to dividing by the number of segments because it properly accounts for the varying importance of each roadway segment, analogous to the way university GPAs are weighted by course credit hours.

### 1.5. Example

Suppose three road segments are inspected.

| Segment | Lanes | Length (km) | Traffic Category | Weight | Grade | Score | Contribution |
|---|---|---|---|---|---|---|---|
| A | 4 | 1.0 | 4 | 16 | A | 4.0 | 64.0 |
| B | 2 | 0.4 | 1 | 0.8 | B | 3.0 | 2.4 |
| C | 2 | 0.2 | 1 | 0.4 | C | 2.0 | 0.8 |

**Table 3**

Total weight
16 + 0.8 + 0.4 = 17.2

Total weighted score
64 + 2.4 + 0.8 = 67.2

Therefore,
sGPA = 67.2/17.2 = 3.91

This reflects the fact that the major arterial dominates overall network performance.

## 3. Discussion

The proposed weighting system makes the pavement sGPA more representative of the functional importance of roads within a transportation network. Major arterials carrying high traffic volumes have proportionally greater influence on the overall network grade than short, lightly travelled local streets. The methodology remains simple enough for implementation within municipal GIS-based pavement management systems and spreadsheet software.

Future refinements could include additional weighting factors such as:

- Functional road classification
- Truck percentage
- Pavement age
- Remaining service life
- Transit routes
- Emergency access importance
- Economic significance

These variables could further improve the representation of network performance.

## 3. Conclusion

Introducing segment weights significantly strengthens the standardized pavement GPA framework. By weighting pavement condition according to roadway size and traffic demand, the resulting sGPA better reflects the operational importance of each road segment while retaining the simplicity and interpretability of the original grading system. The methodology provides municipalities with a practical performance indicator suitable for infrastructure management, benchmarking, and GIS-based analysis [1].

## Reference

1. Cusack, P. T. E. (2026). *A Standardized Grade Point Average (sGPA) Framework for Urban Pavement Systems: A Scalable Index for Infrastructure Economics and GIS-Based City Evaluation. Annals of Civil Engineering and Management*, 3(2), 1–4.

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