# Economic Analysis on the Use of Recycled Aggregates in a Roadway Structure

Duane Guenther, Colin Wandzura, Rielle Haichert, and Curtis Berthelot

**TAC 2013:** Better, Faster, Safer Road Construction

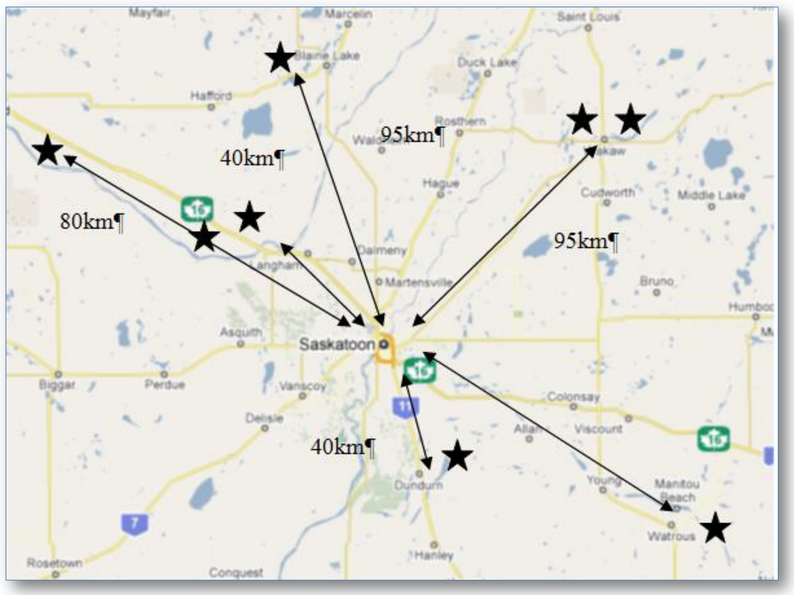

## Abstract:

Recycling aggregate into the asphalt hot mix and new concrete is being identified as the highest economic value of the recycled aggregate. The objective of this paper was to investigate the value of recycled Portland cement concrete (PCC) and reclaimed asphalt pavement (RAP) rubble as engineered structural granular aggregate. The value of RAP as a granular base is significant when viewed in the context of the whole roadway structure. The cost (in Canadian dollars) for new raw materials to construct roadways is between $16.75 and $35.00 per square meter without a drainage layer. Savings of $3.96 per square meter are shown when RAP is used as a structural granular layer, up to 24% of the total material cost. In comparison, $1.22 per square meter of savings is experienced when RAP is used in HMAC, up to 6% of the total material cost. Similar values can be seen with PCC being used in the granular structure, particularly when used as a drainage layer. The cost for new raw materials to construct roadways is between $30.60 and $39.00 per square meter with a crushed rock drainage layer. As recycled PCC aggregates are engineered into the granular structure, $3.96 per square meter of savings is shown when PCC is used in the base layer; and $9.00 per square meter of savings is identified when PCC is used in the drainage layer. The drainage layer is critical to extending the life of a roadway by removing moisture and deep structural strains, particularly in newly developed areas in low lying areas.


# Background:

### Haul Distances

- Haul distances to the City of Saskatoon are up to 100 km away.
- Transportation costs often exceed half the cost of the aggregate and cause haul damage to the roads.




### Using Recycled Materials in Roads

- City of Saskatoon allows a maximum of 15% RAP in its local road hot mix asphalt concrete (HMAC) surfaces.
- No RAP is allowed in arterial or collector roadways.
- Crushed PCC has been trialed in COS roadways as an aggregate substitute or as backfill materials.
- Other jurisdictions used crushed PCC as base/subbase material.
- COS has used crushed PCC as a drainage layer.
- Issues with using PCC and RAP include high fines content, variability in material, source material not being controlled stringently enough, field performance, etc.


### Crushing RAP and PCC Aggregates

- PCC rubble is typically comprised of demolished buildings, sidewalks, and medians; it can be crushed into a drainage rock.
- RAP rubble is typically comprised of aged HMAC surfacing removed from utility cut repairs or milled from resurfacing projects. Both sources of RAP rubble can be crushed into a high quality base aggregate.
- The City of Saskatoon public works operations and capital projects generate over 30,000 tonnes of rubble annually.

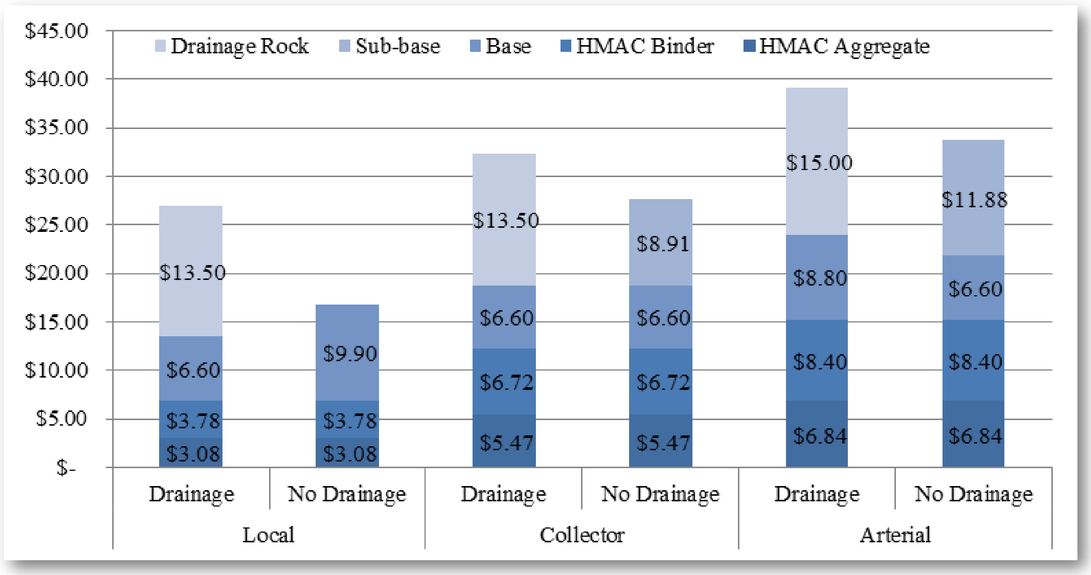

PSI Technologies Inc.

# Crushed PCC Bulk Density Comparison:

- *Testing currently underway.*

# Economic Evaluation:

**Raw material costs for City of Saskatoon Roadway Structures:**

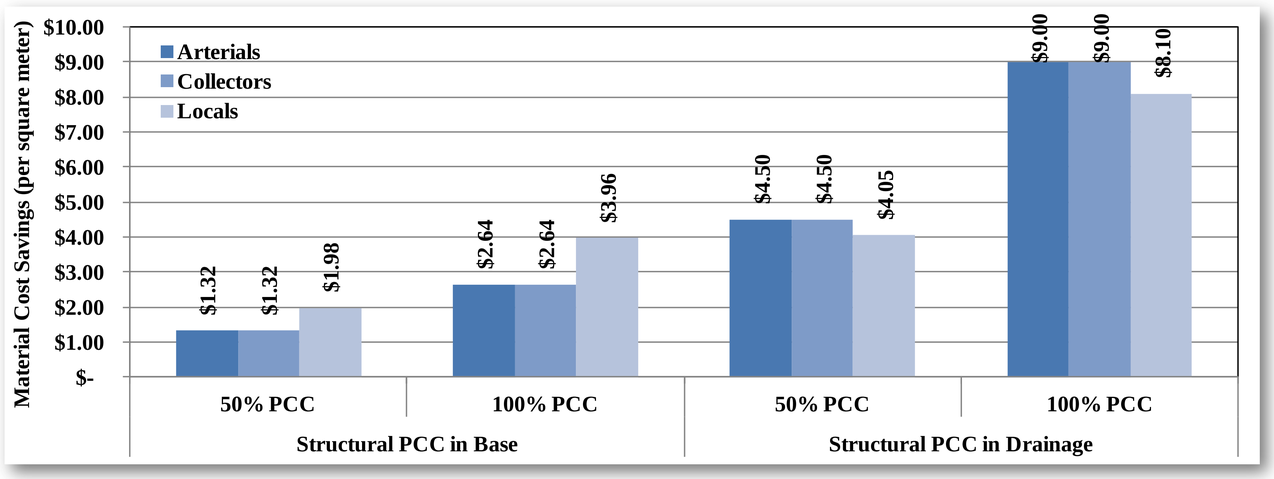



- Location of Recycled materials is key:
  - Large portion of roadway cost is in the granular layers.
  - Increased opportunity for recycling in the granular layers.
  - Less risk to the owner due to slight variability in source material.

- Drainage layers add value:
  - Better structural capacity.
  - Reduces the required thickness of granular base.

- PCC granular material reduces cost by:
  - Reducing haul distances as stockpiles can be located in or near urban areas.
  - Increased aggregate angularity due to material processing which creates an optimal material that can be placed in thinner layers.
  - Zero waste from material processing.

**Cost savings of using PCC in base layers and drainage layers:**




# Conclusions:

PSI Technologies Inc.