

RAP In Washington State

A 32 Year Legacy

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December 16, 2009



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History of RAP in WSDOT

- Hveem RAP mixes
 - Studies
 - Conclusions
- Superpave and RAP
 - Studies
 - Conclusions

First WSDOT RAP Project

- First Project: 1977
- “Rotomill Planing and Recycling Asphalt Concrete in Washington” by Roger LeCler, State Materials Engineer
- “Recycling Asphalt Pavements”
FHWA-DP-39-3 (Aug 1978)
- Project at the height of the energy crisis

1977 Project Details

- Paved in 1977 – 5 miles of 4 lane divided highway, I-90 near Ellensburg, WA
- Mill and fill
- 100% RAP
- Considered:
 - Rejuvenating agent (Cyclepave)
 - To reduce (restore) binder viscosity
 - Additional AR 4000W (up to 2%)
 - Hveem mix design procedure

1977 Project Details

- Final mix design:
 - Used 27.5% new aggregate (chips, from 5/8” to 1/4”)
 - 0.75% rejuvenating agent (about 16%-17% by weight of binder in old pavement)
 - No additional AR 4000W was added
 - Paved a 0.06ft OGFC as wearing course

1977 Project Details

- Performance:
 - Good. No early rutting due to plastic flow.
 - Pavement would show good wear characteristics over the next 10 years.

1977 Project Details

- Conclusions:
 - Rejuvenators, both type and quantity, are key
 - Preliminary mix design is critical
 - Milling generates large quantities of fines
 - Laydown, compaction behaved identical to a mix with 100% virgin aggregate
 - Poor air quality due to baghouse, not due to recycling

Second WSDOT RAP Project

- 1981
- “Washington State Department of Transportation’s Second Asphalt Concrete Recycling Project - Yakima River to West Ellensburg Interchange”
 - I-90
 - Contract No. DOT-FH-11-8007
 - Task Order No. 11
- By Jim Walter, P.E.

1981 Project Details

- New steps:
 - Specification requires 100% of RAP must pass through a 1" screen
 - Contractor elects to crush RAP to meet spec
- Paving (laydown) – no different from a virgin aggregate mixture

1981 Project Details

- Problems:
 - Selecting proper type and amount of rejuvenator
 - Estimating degradation of aggregates due to milling and subsequent increase in P-200
 - Determining proper amounts of new aggregates
- Pre-design work extensive and not easy to turn over to the contractor
 - Only a few (2) Hveem Kneading Compactors in the state

1981 Project Details

- Successful
 - Air quality – in spec
 - Energy usage – lower than virgin mix
 - Performance under traffic – good performance for over 10 years

1981 Project Details

- Conclusion of the Report:
 - Recycled pavements perform satisfactorily
 - Recycled pavements are cost effective

Summary of WSDOT RAP Projects: 1977- 1986

- 24 RAP projects reviewed
- “Hot Mix Recycling Evaluation in Washington”
 - Final Report (WA-RD 98.2)
 - December 1986
- By: Art Peters, Bob Geitz, Jim Walter

1977-1986 RAP Review

- Two initial projects (1977 and 1981) still performing well in the field, one of them nine (9) years old, one five (5) years old
- First project (titled “Renslow to Ryegrass”) built in 1977 had a 1986 pavement rating of 83 on a 0-100 rating scale, with 100 = new and 0 = very poor

1977-1986 RAP Review

- Pre-contract, pre-mix design work included testing with RAP proportions of 0%, 30%, 50% and 70%.
- Specification allows 5-point reduction in Hveem stability

1977-1986 RAP Review

- Specs allow variable RAP, up to 100%
- 16 projects with RAP varying from 8% up to 79%, at contractor's choice
- Covered with OGFC except for a few test areas
- Test area performed about the same as OGFC areas or better
- Saw up to 34% reduction in bid prices
- Projected 10-15 year wearing surface pavement life (typical average wearing surface life)

1977-1986 RAP Review

- Problems:
 - Too much effort in the preliminary mix design stage
 - Too many unknowns at bid:
 - Final gradation
 - Oil content
 - Rejuvenator need
 - New aggregate need

Based on 1977-1986 Review

- Change:
 - 1988
 - Allow 10% RAP max. in all mixes
 - Eliminate specialty preliminary mix design work
 - 1991
 - Allow RAP on any project
 - Fix the maximum percentage at 20%
 - No change in bidding compared to virgin mix, so everyone bids on equal footing
 - No specialized preliminary mix design work

Why did we change?

- Intensive, extensive mix design work
- Pavement samples
- Extractions
- Gradations
- Testing
- Trial blends

Why did we change?

- Variable percent of rejuvenator
- Variable blend of aggregates (chips)
- Variable amounts of AR 4000W
- Variability between sample and actual
- Difficulty in obtaining RAP samples
- Difference in milling machines and in milling vs. large chunks of ACP

Bottom line:

- Too much investigatory work in preliminary mix design stage
- Too many variables
- Too difficult to write specs and to put bidders on equal footing
- Need to move to performance based, rather than method based, specs

From Hveem to Superpave

- WSDOT Superpave projects began in mid-90's
- Examined:
 - RAP effects on PG Binder
 - Superpave and RAP in field

RAP and PG Binder Testing

- “The Use of RAP with PG Asphalt Cement” by Bob Briggs
- Studied the impact of RAP to virgin binder properties
- Mixed virgin PG 64-28 and binder recovered from RAP
- Looked at different concentrations of RAP to virgin binder

RAP and PG Binder Testing

- Found that adding up to 20% RAP reduced the reliability factor only slightly, from 98% to 95%.
- Minor impact to grade of PG
- RAP affects binder by slightly:
 - Reducing the potential for rutting
 - Increasing the potential for fatigue cracking
 - Increasing the potential for raveling

RAP and PG Binder Testing

- Conclusion:
 - We can use up to 20% RAP with little to no impact to the PG grade of asphalt cement as specified
 - Slight increased risk is lost in the “background noise” of other unknowns (temperature regime, traffic, QC and QA, etc.)

RAP and Superpave

- Specifications allow 20% RAP with Superpave with no other adjustments
- All Superpave specs intact
- Reviewed projects paved with Superpave and 20% RAP
 - No loss of performance to date
 - Most projects only 11 years old or less

RAP and Superpave

- We use all the RAP we produce
- Cities and Counties follow our lead
- Per WAPA, we are recycling 100% of our asphalt pavements

RAP and Superpave

- Critical factors for success:
 - Same as for Superpave without RAP
 - Design the aggregate structure
 - Crush to the design
- QC is the key to success:
 - Gradation
 - Oil content

Thank You

- Questions?