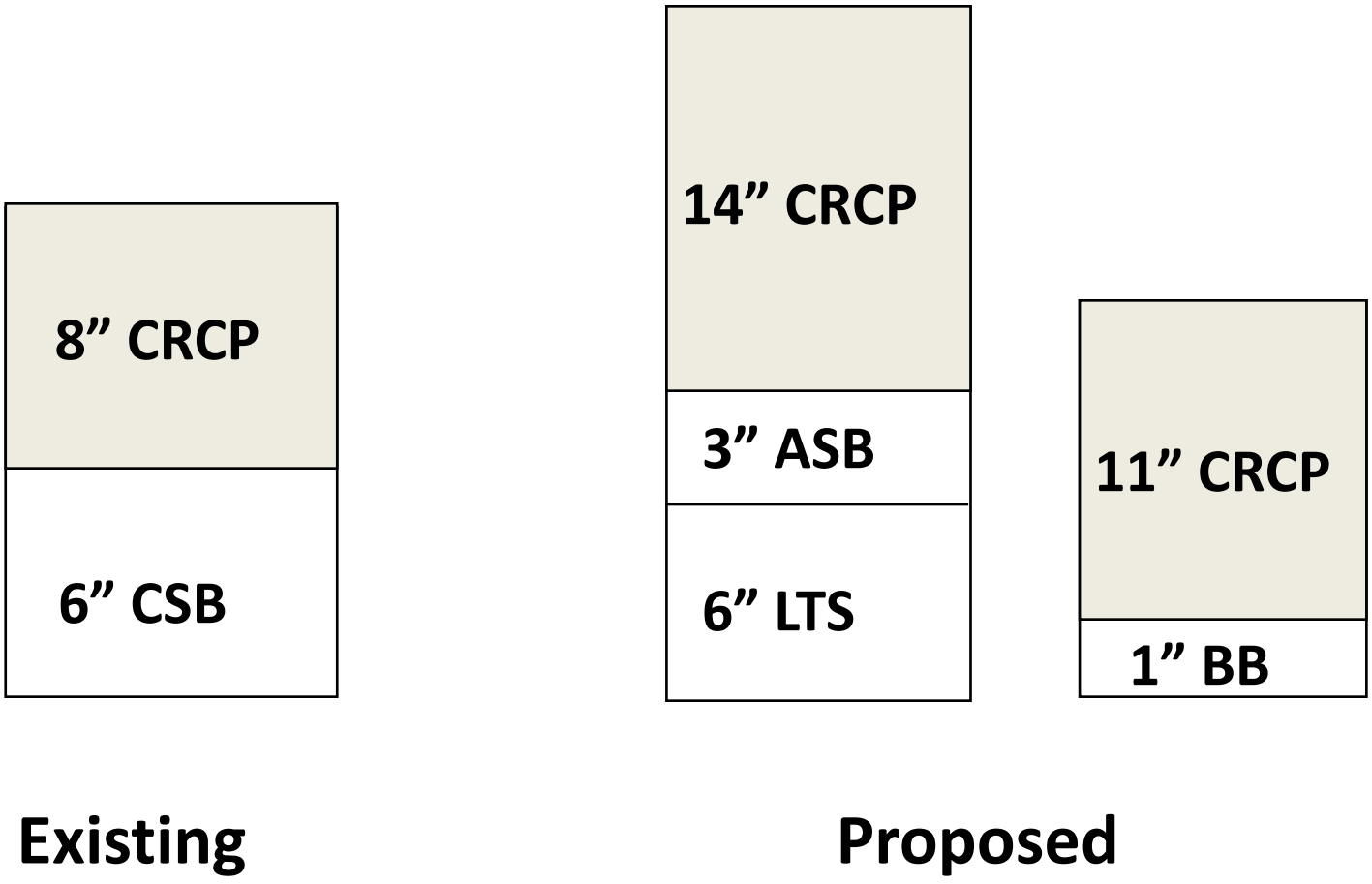
RCA
IH 10

- Houston District
- IH 10
- 1995 to 1998
- 11”

Background

- Rehab Project in Houston, Texas
- I-10 between I-45 & Loop 610 West
- Project Length: 5.8 Miles
- Existing CRCP: Constructed in 1968
- Rehab Project: 1995-1998
- 10 Lanes + HOV
- No Virgin Aggregates Used for Concrete- All RCA (Both Coarse & Fine)

Pavement Structures



Outline

- Background
- **Materials Evaluations**
- Pavement Performance
- Findings & Conclusions

Material Evaluations

- **RCA Properties**
- **Concrete Properties**

RCA Properties

- Specific Gravity: 2.4 ~ 2.5 for CA & FA
- Water Absorption: CA - 3~5 % FA - 6~9 %
- Reclaimed Mortar Content
- Sulfate Soundness Loss
- LA Abrasion Loss
- Angularity

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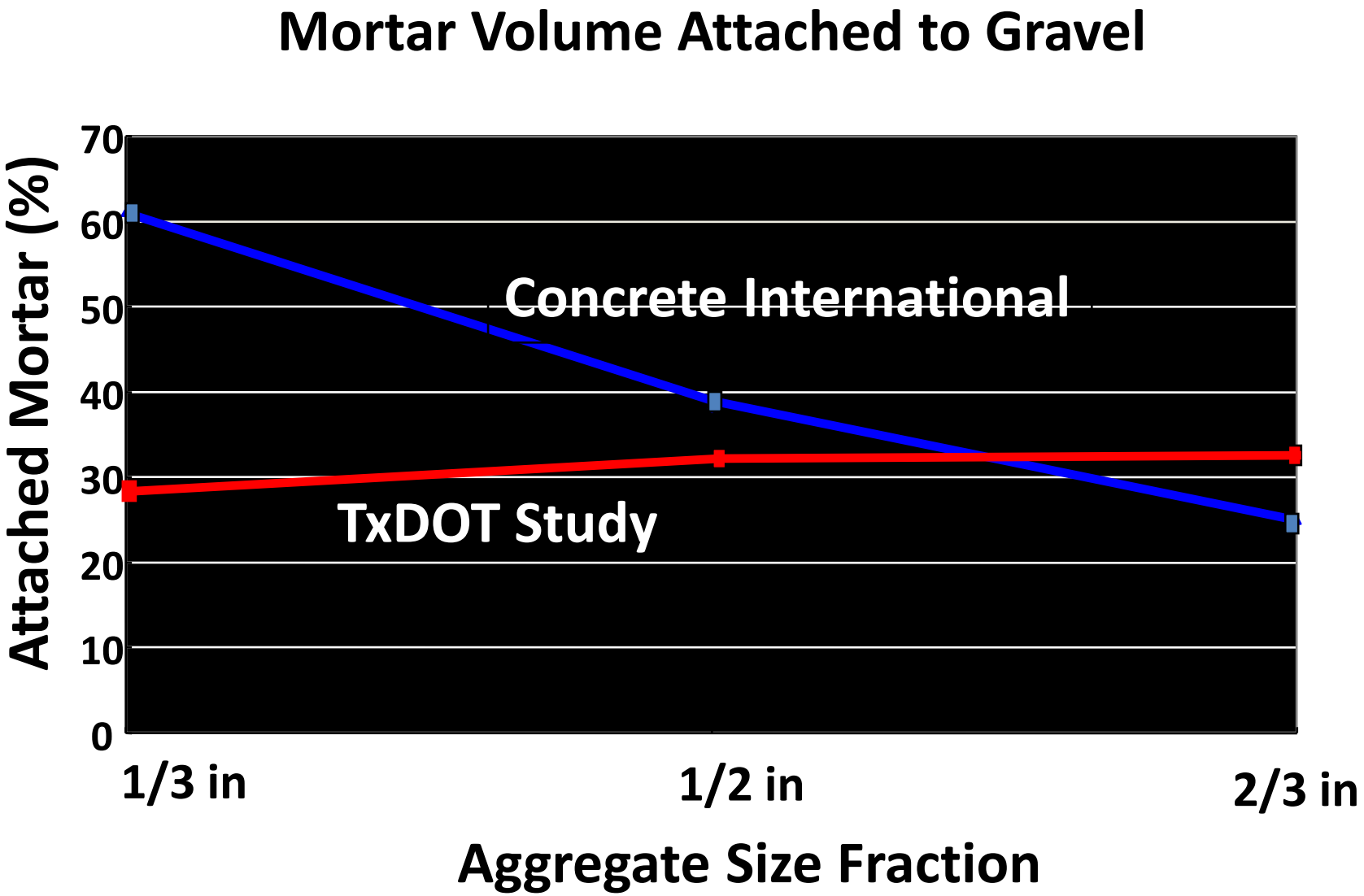
Mortar Volume Attached to Gravel
Attached Mortar (%)
70
60
50
40
30
20
10
0
Concrete International
TxDOT Study
1/3 in
1/2 in
2/3 in
Aggregate Size Fraction

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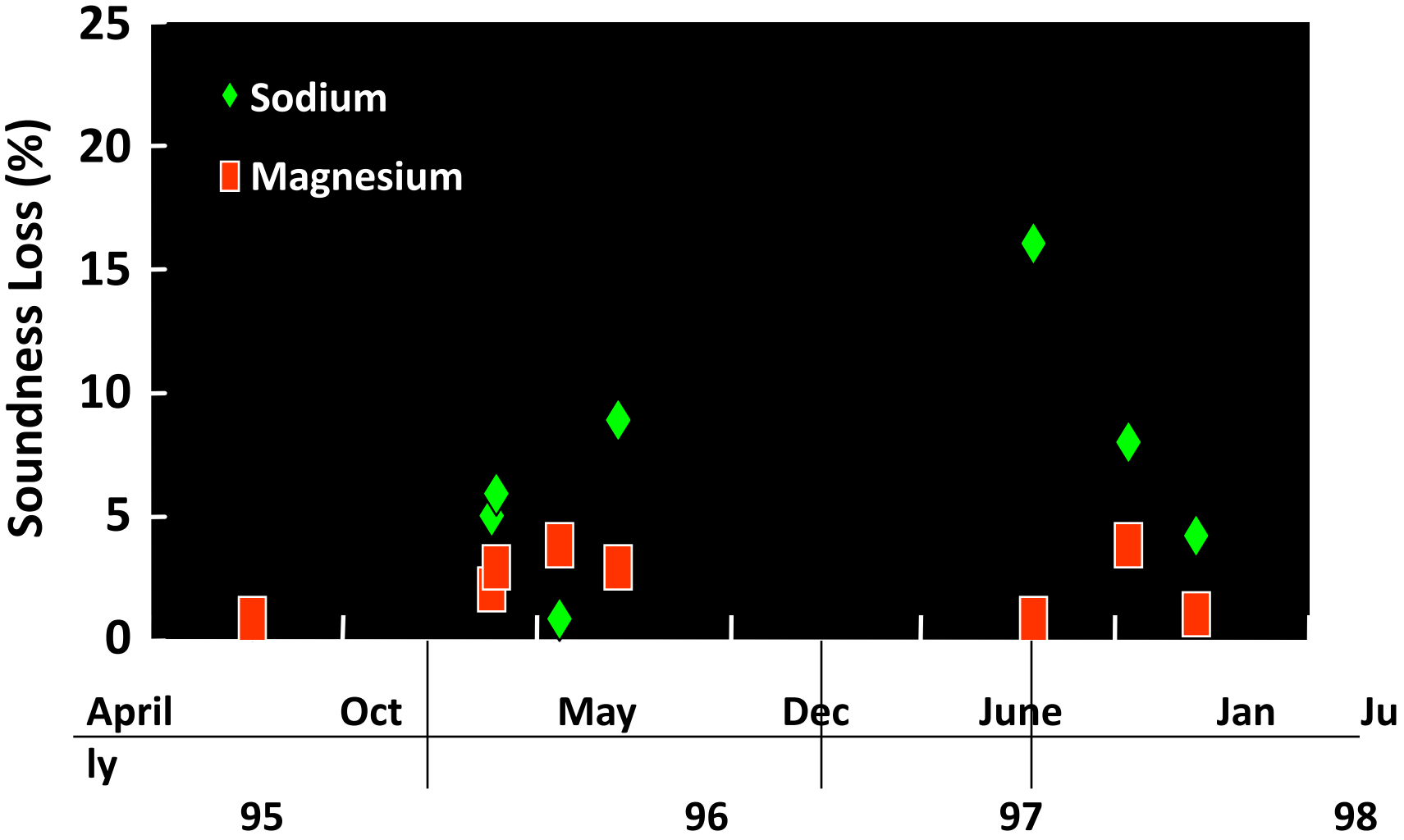
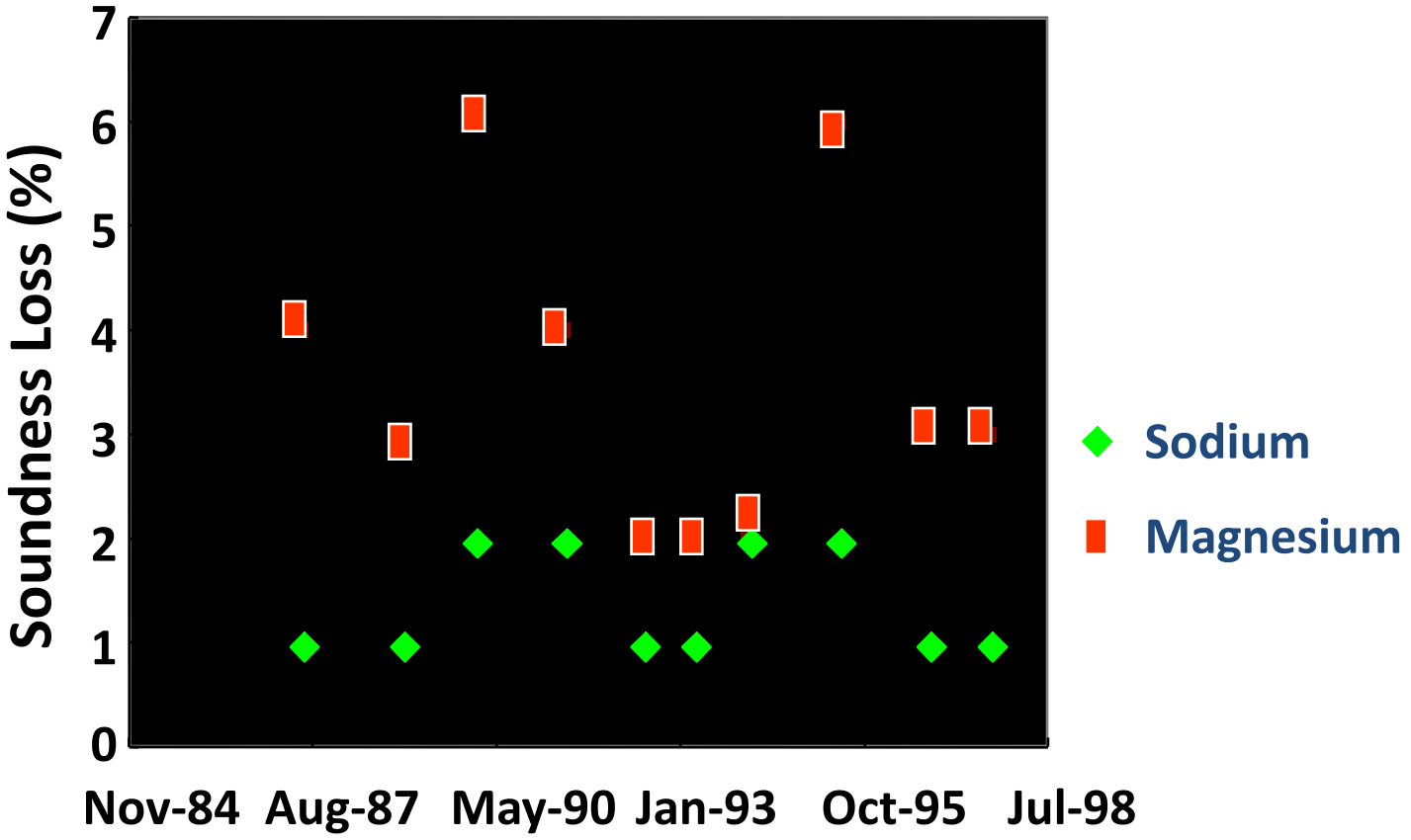
Soundness Loss of RCA



Soundness Loss of Gravel



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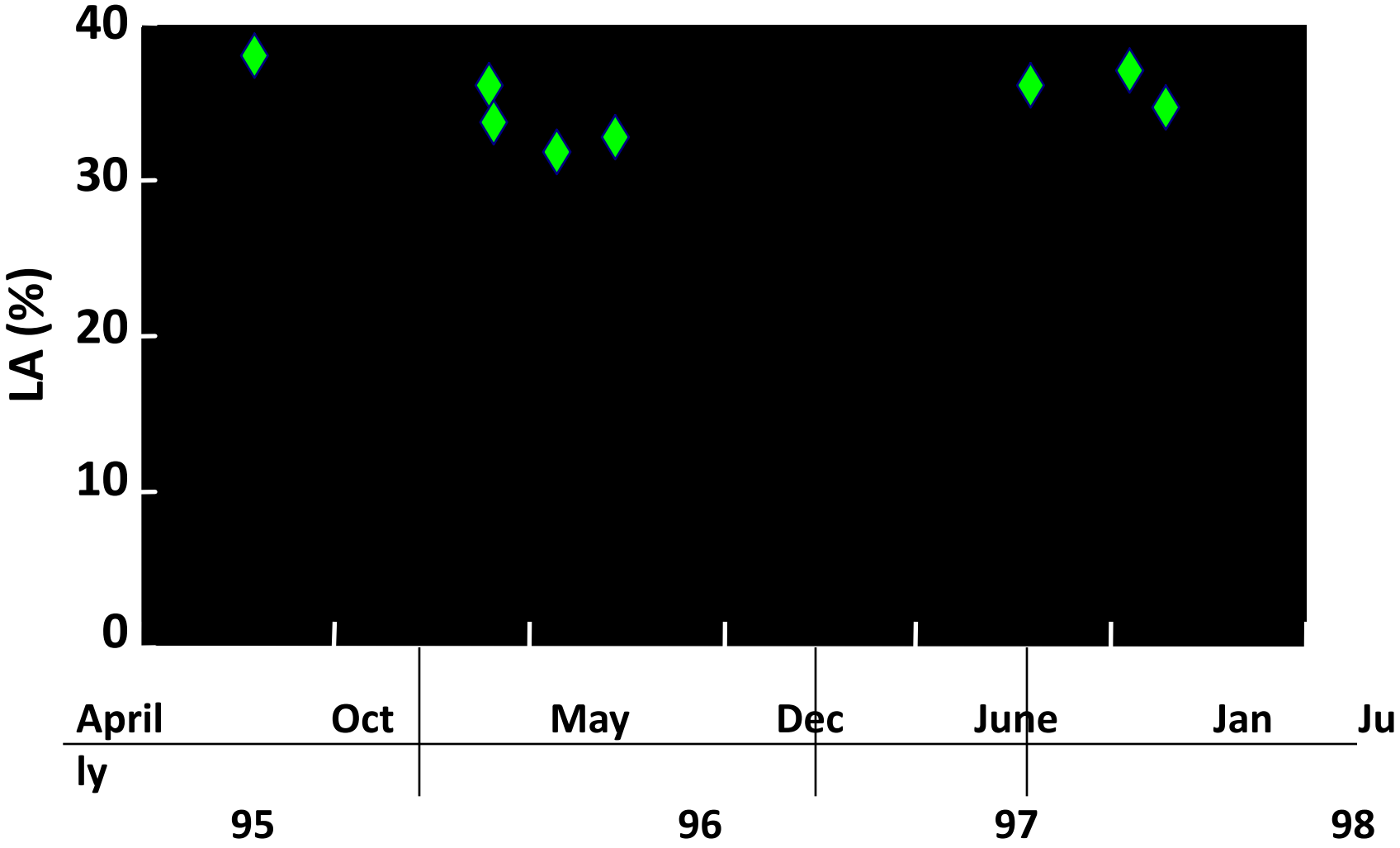
40
30
20
10
0
LA (%)
April
Oct
May
Dec
June
Jan
Ju
ly
95
96
97
98

RCA Properties

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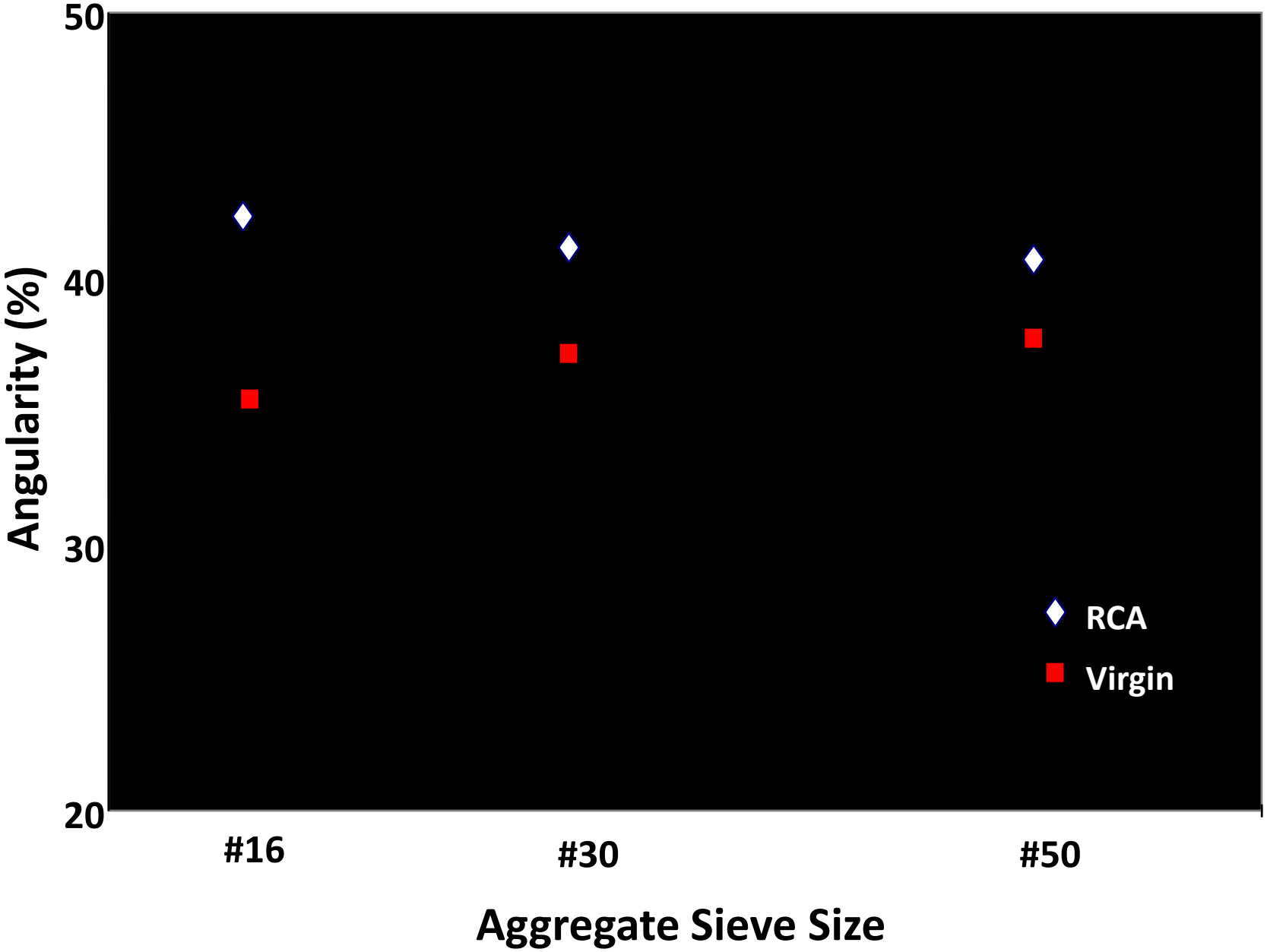
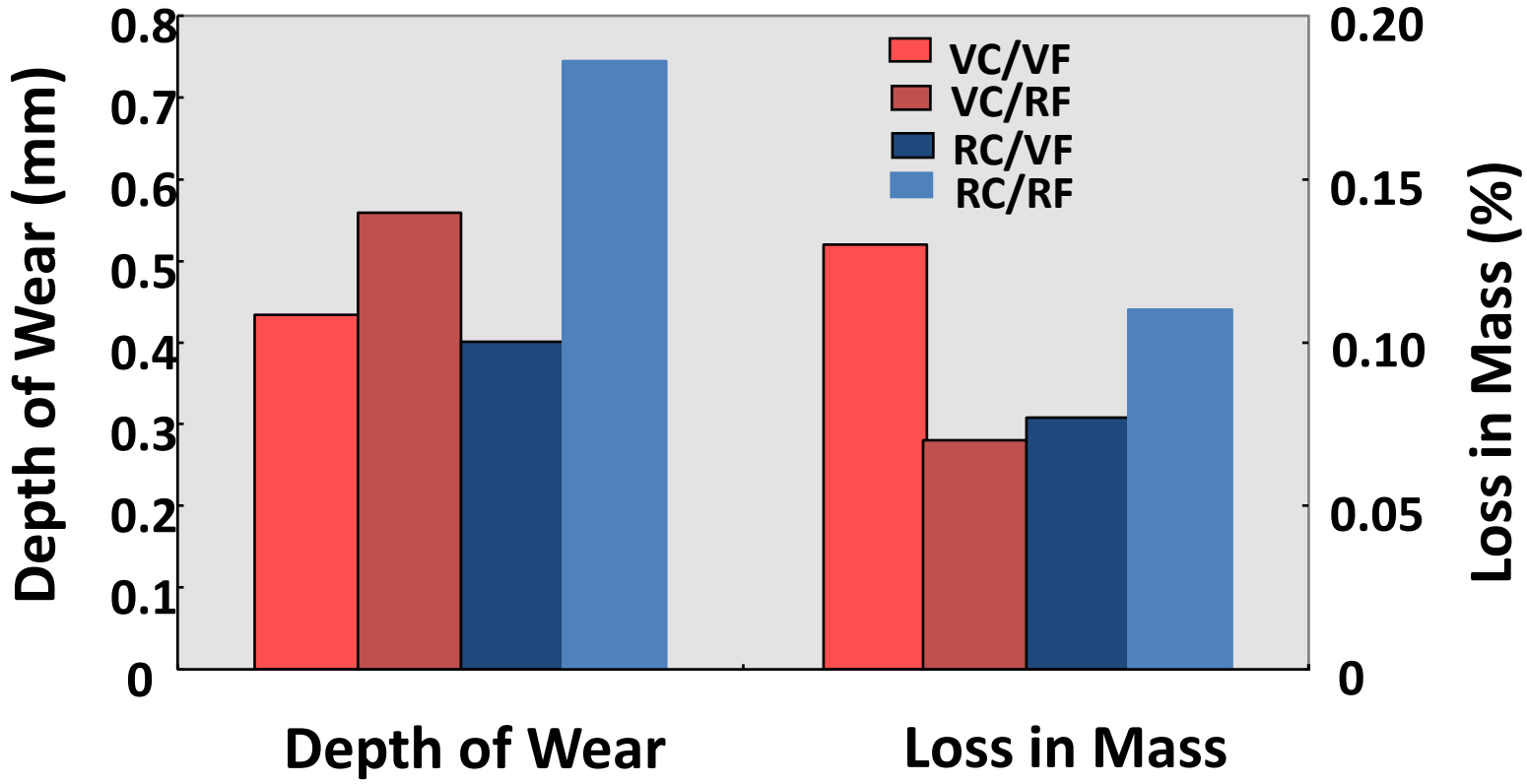
- **Angularity**


50
40
30
20
Angularity (%)
#16
#30
#50
Aggregate Sieve Size
RCA
Virgin

Abrasion resistance of various aggregate mixes



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Pavement Performance

- **Crack Spacing Distribution**
- **Spalling**

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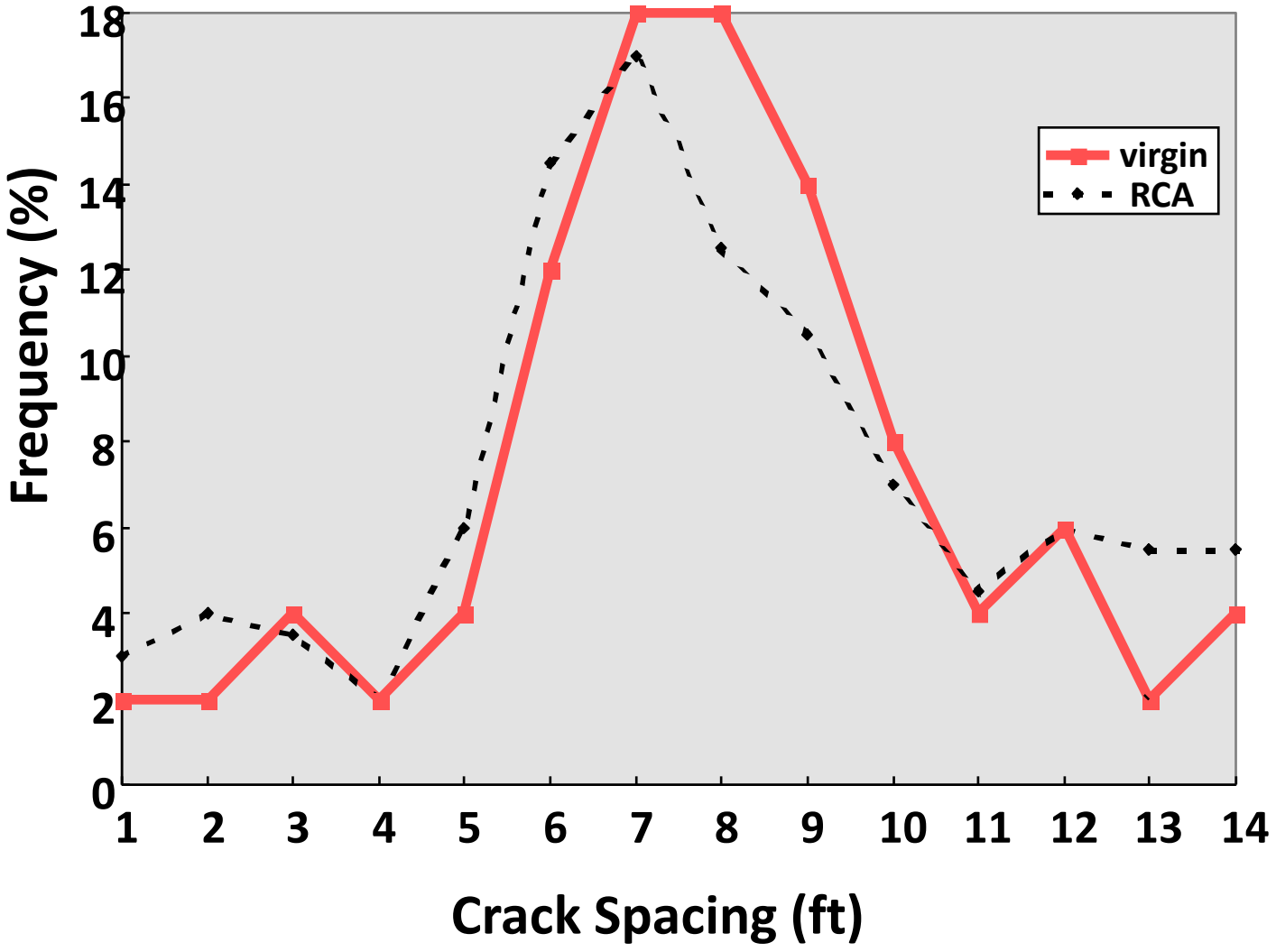
Crack Spacing Distribution of Virgin & Recycled Sections



Pavement Performance

- Crack Spacing Distribution
- **Spalling**

Spalling

Findings & Conclusions

Aggregate Properties

- **The properties of RCA measured in this study are consistent with those reported elsewhere.**
    1. **Gs**
    2. **Water Absorption**
    3. **Sulfate Soundness Loss**
    4. **LA Abrasion Loss**
    5. **Angularity**
- **Sodium sulfate causes more damage to recycled aggregates than magnesium sulfate does.**

Findings & Conclusions-cont'd

- **Concrete Properties**

- **Recycled fine aggregate has an adverse effect on strength.**
- **The use of both recycled coarse and fine aggregates reduces modulus of elasticity of concrete substantially.**
- **Thermal coefficient of concrete with 100% RCA is higher than that of virgin aggregate concrete.**
- **The effect of recycled aggregate on the abrasion resistance of concrete is inconclusive.**

Findings & Conclusions-cont'd

Pavement Performance

- **CRCP utilizing 100% recycled coarse & fine aggregates has performed well.**
- **The large amount of old mortar in RCA does not appear to have adverse effect on CRCP performance.**
- **Moisture control of recycled aggregate is critical in producing consistent and workable concrete.**
- **No significant adjustment is necessary in paving operations due to the use of 100% RCA.**

Findings & Conclusions-cont'd

Spec Changes

- **Coarse Aggregate: Coarse aggregate shall be washed and shall consist of durable particles of gravel, crushed blast furnace slag, crushed stone, or combinations thereof. ('93)**
- **Coarse Aggregate: Provide coarse aggregate consisting of durable particles of gravel, crushed blast furnace slag, recycled crushed hydraulic cement concrete, crushed stone, or combinations thereof. ('04)**