Integration into new design method, and consideration of pavement vehicle interaction, freight damage and logistics

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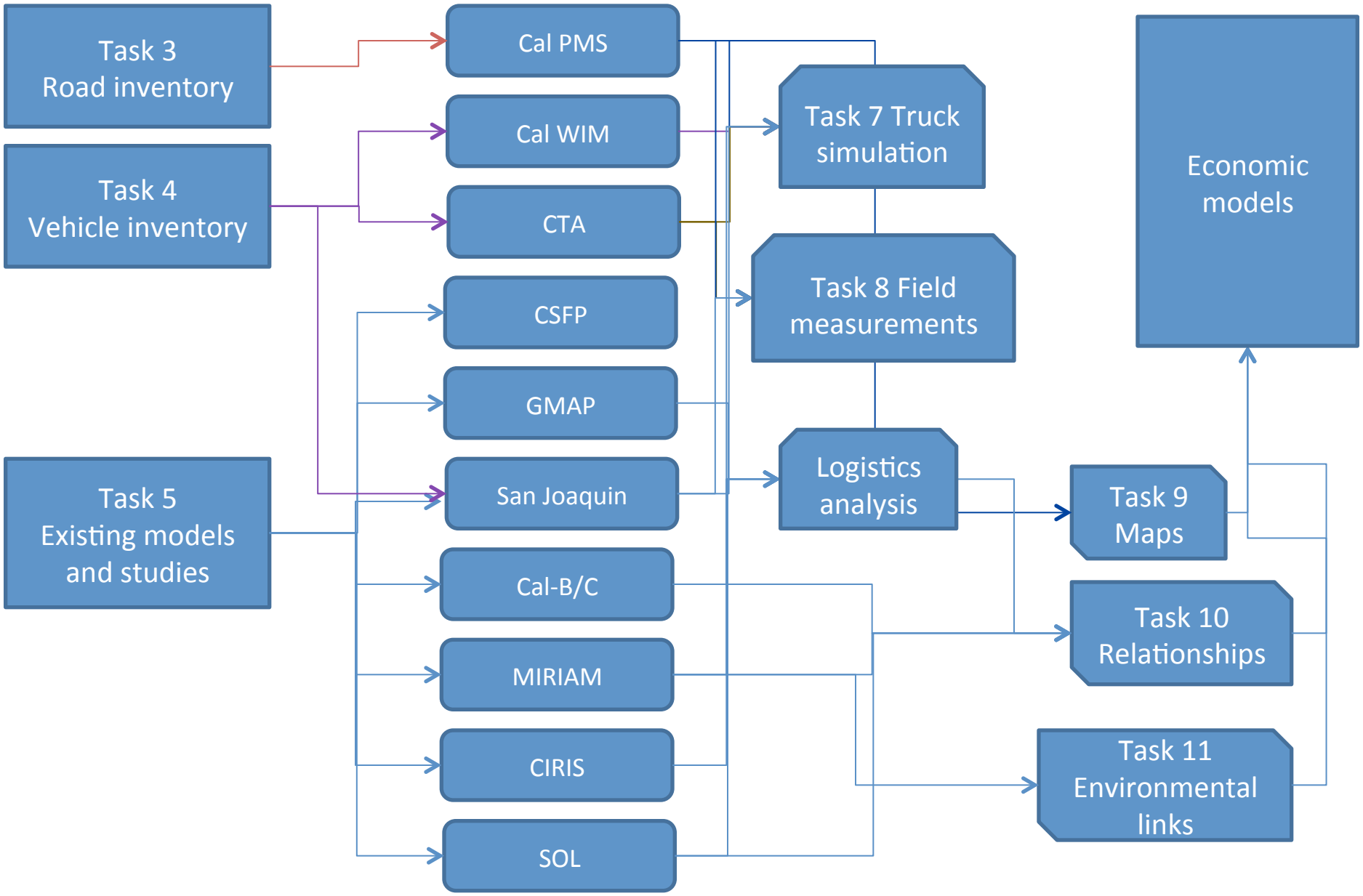
Topics

- Consideration of
  - Vehicle-Pavement Interaction (V-PI)
  - Freight damage
  - Freight logistics

- Design methods
  - Integration of LCA aspects
  - SA National Roads Agency Limited (SANRAL) implementation

Caltrans Pilot Study



V-PI Consideration

- Importance of V-PI in road condition established
- Various studies over many years – also at this conference
- Recent pilot study by Caltrans to evaluate possibilities of incorporation in various economic transportation models

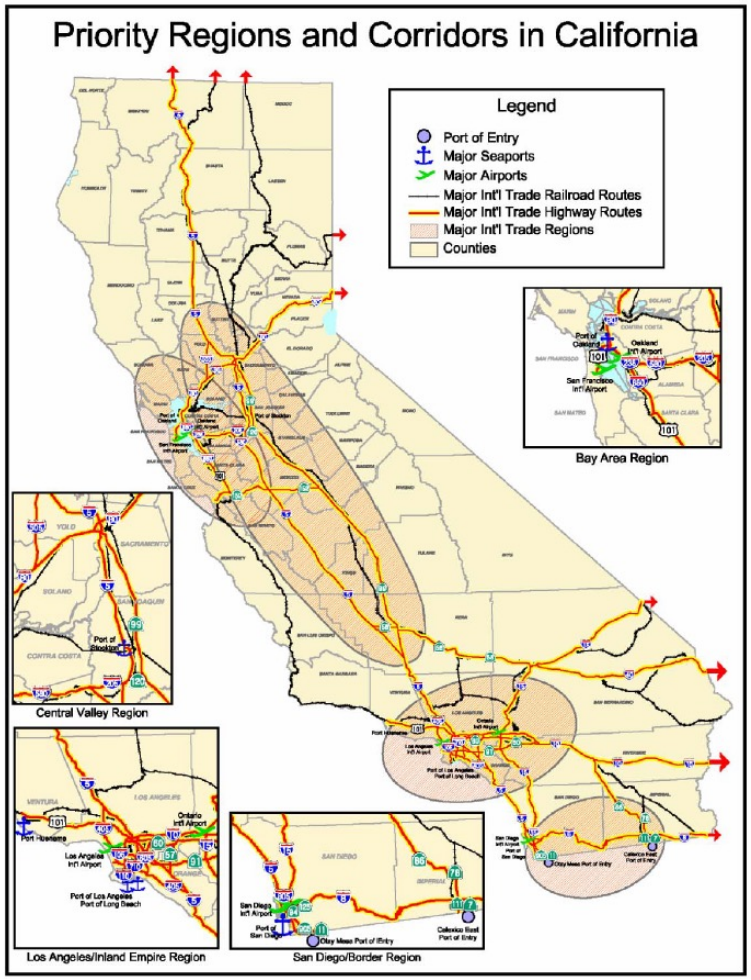
Field Work Setting

Central Valley Region

- Mainly Agriculture – produces 1/2 of all fresh produce for US
- Unprecedented population growth fuels consumer demand, population 3.6 million
- Increases in warehousing & distribution; relocating from the Bay Area

Bay Area Region

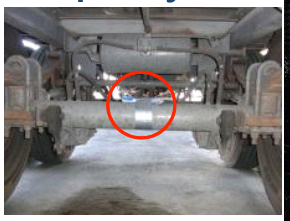
- >37% of econ activity: manufacturing, freight transp/warehousing/distrib
- Approx $6.6 billion per year spent on freight transport services
- Trans-Pacific - Oakland over LA/Long Beach for destinations farther east
- 7.1 million people; 2.1 million jobs



V-PI Field Work

- Actual V-PI data collected
- Volunteer private firms
  - Anonymized
    - Agriculture transport and processing, “Company A”

    - Less Than Truckload (LTL), “Company B”

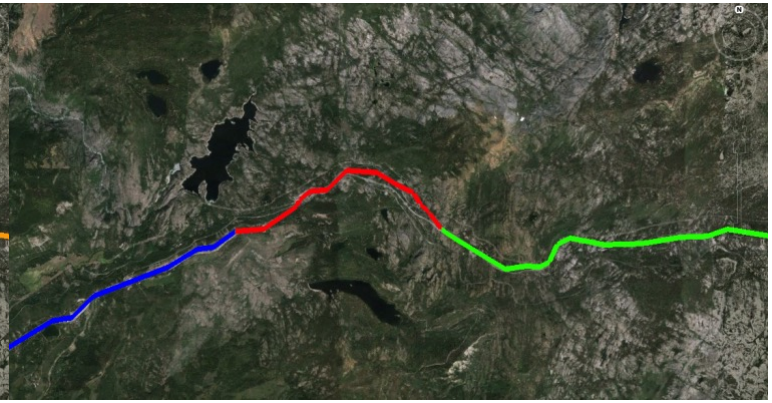


- US Interstate and rural routes

V-PI Maps

Roughness

Tire loads; Emissions;
Vertical acceleration; Fuel consumption



Tire wear

Repair and maintenance

- Very Good
- Good
- Average
- Poor

V-PI Environmental Links

- Various sources for relationships
  - Environmental emissions
  - Need for localized models – LCA (UC Davis)
- Linkages to economic models
  - Speed related effects

Freight Damage - Tomatoes

- Determine potential damage to tomatoes due to road conditions
- Based on measured data
- Acceleration analysis from field measurements
- Determine frequency bands of interest for different routes and locations

Freight Damage – Sensors

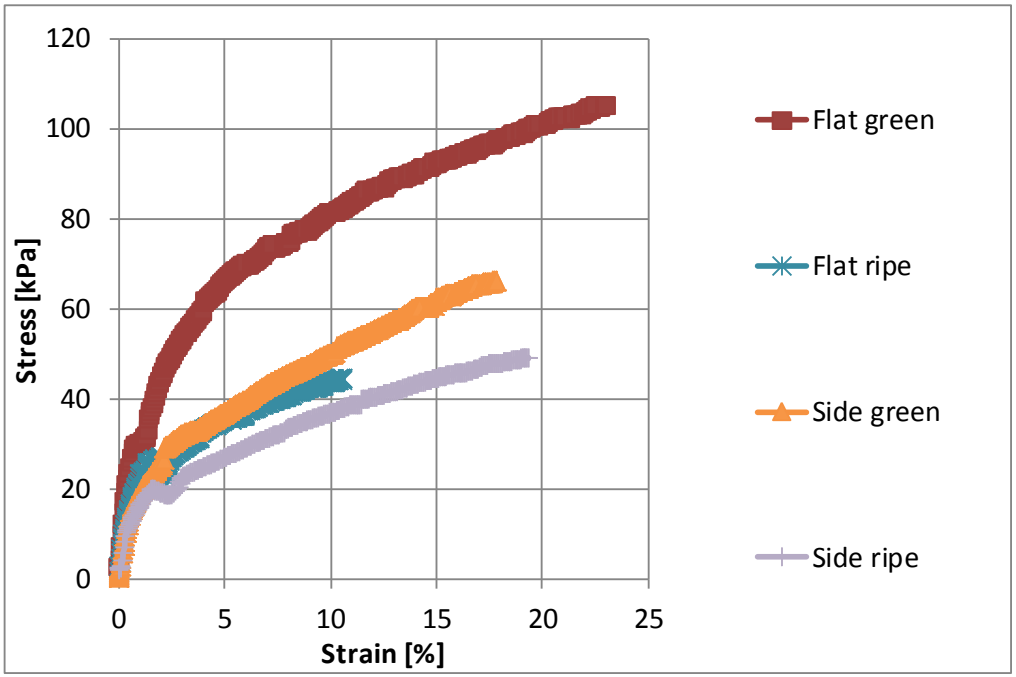
- Acceleration sensors (field and laboratory)
  - Measures accelerations
  - Same sensors used on trucks

- Pressure mats (laboratory)
  - Measures contact σ
  - In-between layers of tomatoes

- Video (laboratory)
  - Keeps track of changes and progress

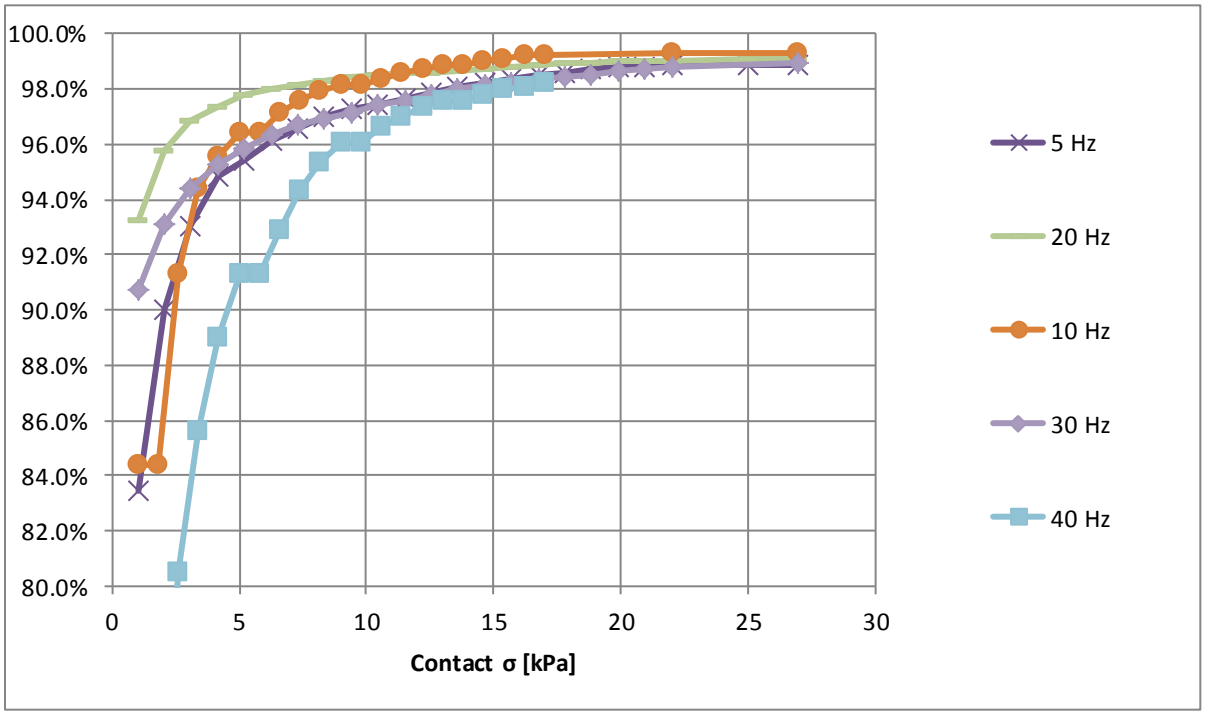
Test Methodology – Analysis

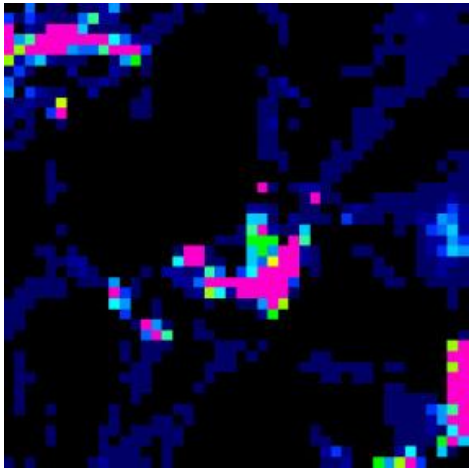
- Analyse
  - Measured accelerations
  - σ/ε relationship for tomatoes
  - σ data
  - Stress-ratio calcs to determine damage / failure



Freight Damage – Lab Results

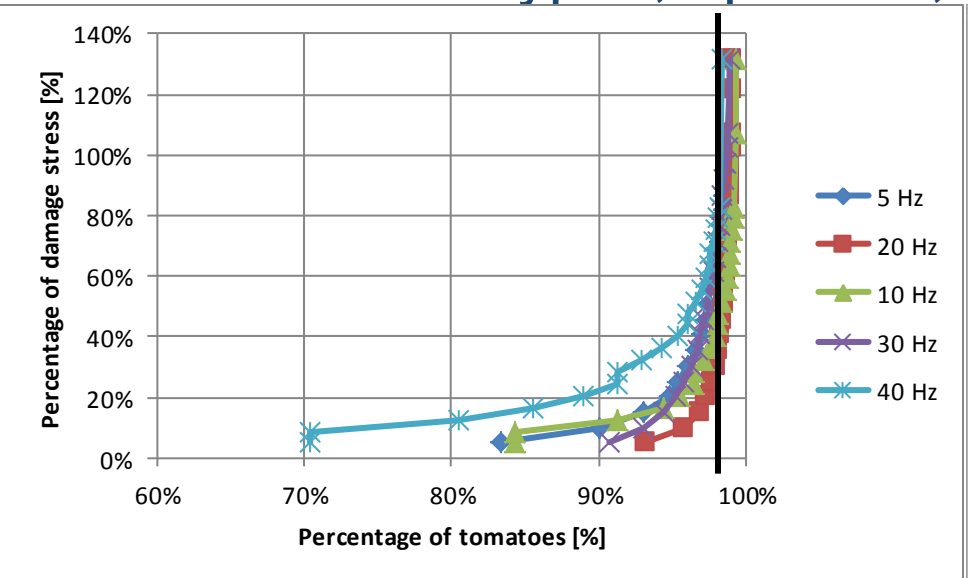
- Tomato damage and failure defined
- Typical contact σ measurements
- Cumulative contact σ distribution
  - 5 major freq.'s from field work (trucks)

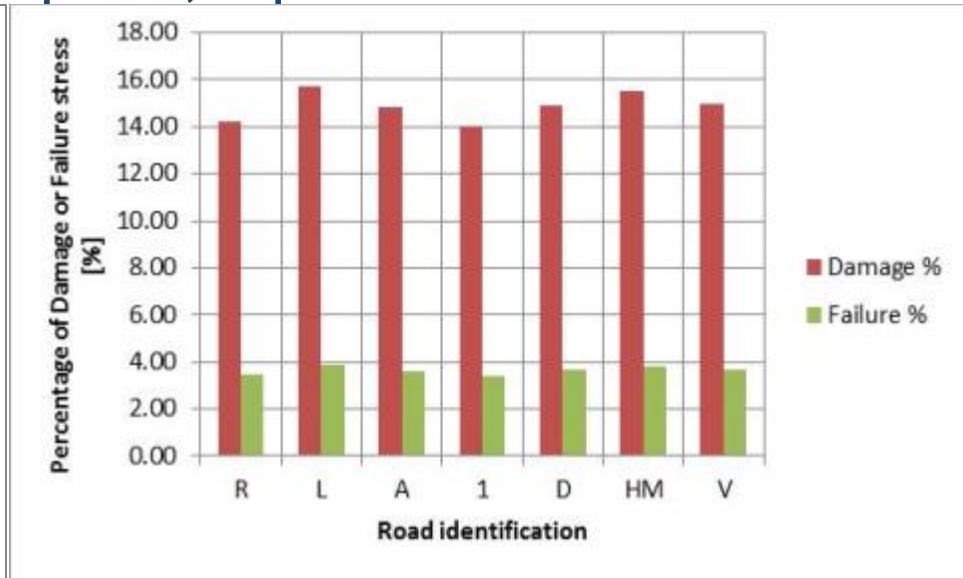




Linking Freight Damage to VPI

- % of tomatoes at 95th% of damage or 95% of failure stress for different roads
  - 1 location on truck
- Output agrees with field experience
- Current limitations (pilot study)
  - Tomato types, ripeness, speed, trip duration





Freight Damage Conclusions

- Can measure contact σ in laboratory model
- Can calculate actual contact σ as % of damage / failure σ
- Data appears representative of damage/failed % in practice (per private firm)
- May be utilized as performance measurement rating for pavement / freight system
  - Linked to maps for routes and commodities in specific area
- Follow-up studies, expanding the pilot study are needed

V-PI Conclusions

- Road roughness data + appropriate models and relationships = **evaluate economic effect of road use** (VOCs, potential vehicle and freight damage) – **Road users and owners**
- Use relationships (road roughness + various parameters) - select optimal routes where VOCs / damage are minimized – **Road users**
- Evaluate effect of different levels of construction and maintenance quality control on infrastructure condition + general transportation costs / infrastructure deterioration rates as affected by road roughness – **Road owners**

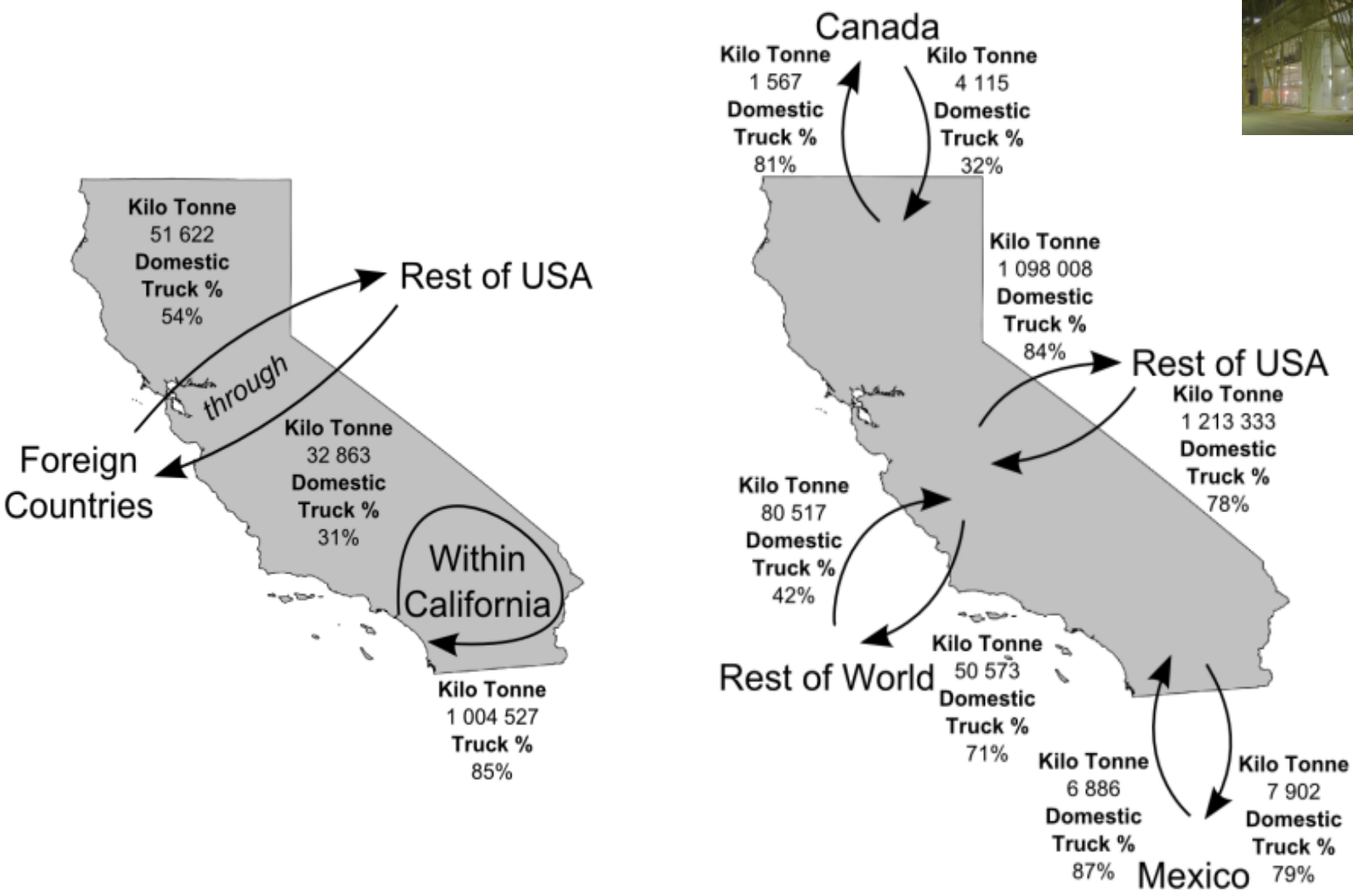
Freight Logistics Consideration

- Damaged freight results in direct and indirect losses in potential revenue through effects on logistical operations
- Potential freight damage savings accrued by road improvement must be given as input into Cal-B/C model
- Potential links to LCA
  - Effect of freight logistics costs on LCA use phase evaluations

Why Logistics Matters in Calif.

- Drivers of freight growth: Increasing ...
  - Consumption (due to Population + Econ growth)
  - Manufacturing output
  - Inventory-pull (just-in-time) systems
  - International trade
- Focused action required for California to handle forecasted freight volumes
- Concern for business AND government
  - Manufacturing, Distribution, 3rd Party Logistics
  - ALL levels of government (fed, state, region, local)

Freight Flow Within and Through California



Integration of LCA into SANRAL Design Method

- SANRAL updated Road Design Method
- Concept and objective
- Components
- LCA integration
- Beta version coming soon
- Workshop at TRB 2015

Acknowledgements

Company “A”

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Company “B”

SANRAL

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FHWA

Thank you! Questions?