Crash Characteristics of Chinese Freeway:

Lessons Learned from Jingjintang Expressway Safety Evaluation

Beijing University of Technology

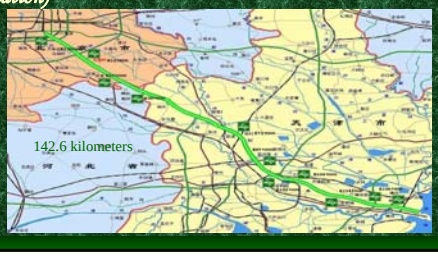
Presentation at the 2006 TRB Annual Meeting for Committee ABE90

Outline

- Background
- Crash Analysis
- Discussion – what are the problems?
- Strategies for Safety Enhancement

Background

Connecting Beijing to Tangu seaport, Jing-jin-tang expressway is one of the first freeways built in China (even before the publication of Chinese Freeway Design Specification)



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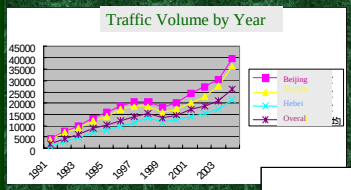
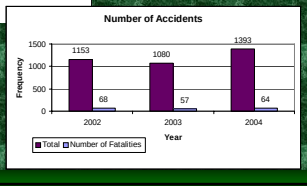


Since the start of full operation in 1993, # of fatal crashes has been increasing as the traffic increases, particularly over the past five years



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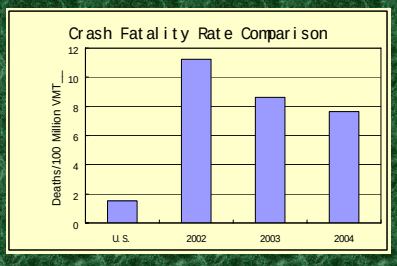

Background

The safety problem of this freeway has become a big concern for the government and the Expressway Authority. Crash occurrence generates lots of notoriety from news media.

Background

To improve the freeway safety, a project was Launched by the Chinese Ministry of Communication.

Accomplished Tasks of the Project

- *Crash data collection and analysis*
- *Traffic flow data collection and analysis*
- *Design Criteria and roadway condition evaluation*
- *On-site truck driver survey*

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Crash Analysis

- *Temporal distribution*
- *Spatial distribution*
- *Type of vehicles*
- *Type of collision*
- *Type of violations*

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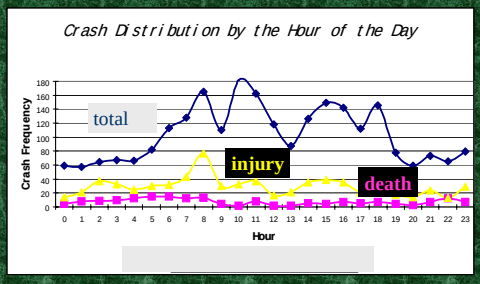
Temporal distribution



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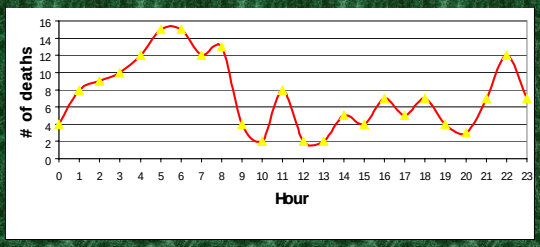
Distribution of fatal crashes by hour of the day



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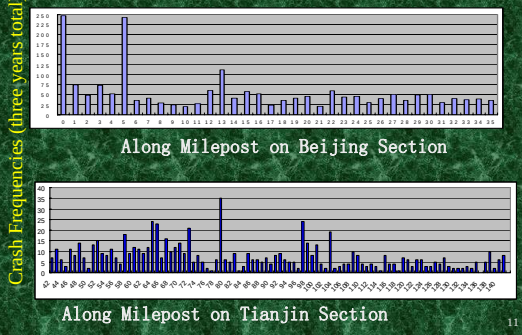
Crash spatial distribution



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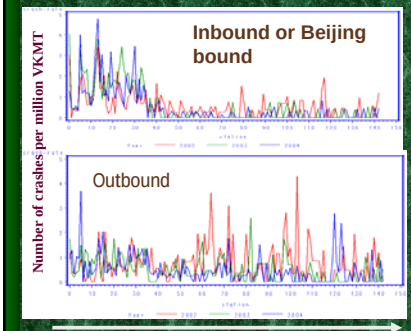
Crash Rate Distribution in Both Directions for 3 years (2002, 2003, 2004)



- *No apparent "black spot", large fluctuation*
- *Distribution varies by year*
- *"End-effect" on Beijing-bound traffic*

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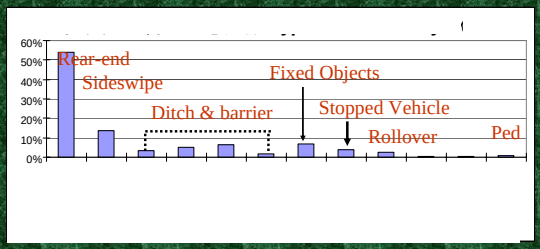
Type of collision



Rear-end collision is the most common crash type (54%), sideswipe (14%), roadside (23%)

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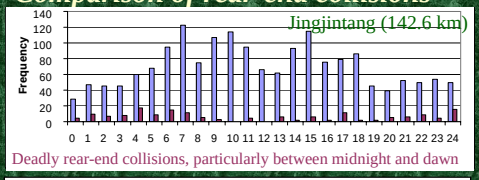
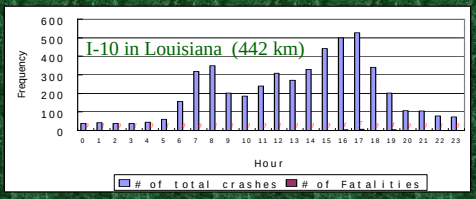
Comparison of rear-end collisions



Deadly rear-end collisions, particularly between midnight and dawn



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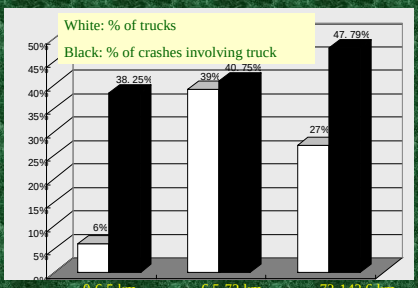
Type of vehicles

Truck Involvement in Three Segments



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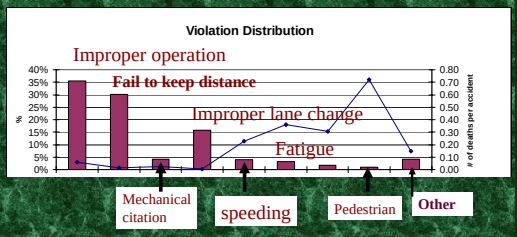
Type of violation



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Discussion

No problems in horizontal and vertical alignment

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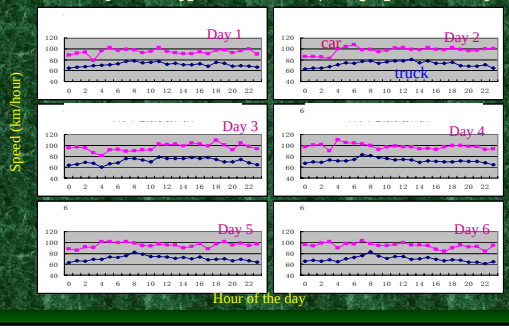
What are the problems?

- *Difference in average operating speed between cars and trucks -- results from one typical cross-section (average speed vs. hour of the day)*



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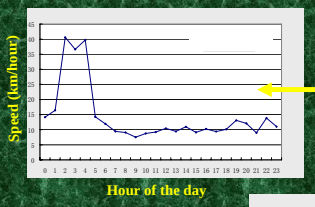
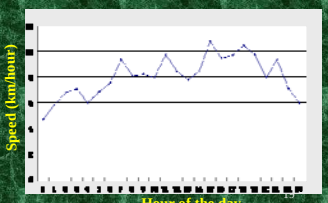
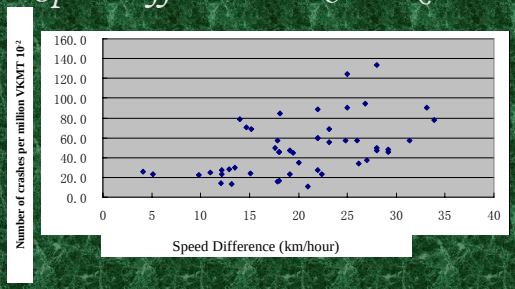


Standard deviation of car speed distribution – mainly caused by human behavior

Standard deviation of truck speed distribution – an indication of truck capability



Speed Differential vs. Crash Rate



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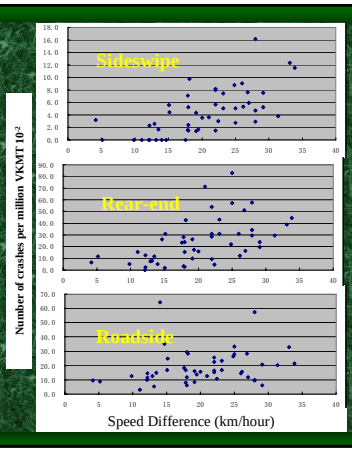
Speed difference v.s. crash rate for three common types of crashes



What are the problems?

- *Narrow shoulder width – legacy of old design standard (because there is no real time enforcement)*
- *Frequent heavy vehicle mechanical problems*

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Encountered three disabled trucks within 2 hours of observation during one night last December with police

Frequent vehicle mechanical problems plus narrow shoulders often lead to fatal crashes, particularly at night

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Based on the truck driver survey:

- *91% -- stopped vehicle on the shoulder because of mechanical problems*
- *69% -- shoulder is too narrow for truck*
- *15% -- admitted no delineator placed behind a disabled vehicle*
- *5% -- admitted never making effort in parking a disabled vehicle away from traveled lane*

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Impact of Trucks on Fatal Crashes

Truck % / Crash rate	% of trucks less than 50%	% of trucks bigger than or equal to 50%
Average hourly fatal crash rate	0.174	0.414

$$R = \frac{N_i * 100 * 10^6}{v_i * 365 * L}$$

R - # of hourly crashes per 100 million VMT
N_i - # of fatalities occurred within hour i
v_i - hourly volume during ith hour of the day
L - segment length

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What are the problems?

- *Barrier problem*
  - *Length of need and location*
  - *No crashworthy end treatment*
  - *No crashworthy transition between semi-rigid to rigid barrier*

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Non-breakaway sign post and inadequate barrier length for bridge pier

Guardrail with break at telephone - no tension, minimum protection

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No crashworthy end treatment

From crash testing conducted in the U.S. (video)

Dangerous exit gore installation

What are the problems?

- *Curb on high speed highways has been recognized to be a very unsafe practice; it can easily lead to vehicle overturning or vaulting barrier.*

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What are the problems?

- *No left shoulder – minimum clear zone*

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What are the problems?

Current median barrier is not designed to prevent heavy vehicle penetration; none crash worthy end treatment at median opening

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What are the problems?

- *No shielding of most fixed objects within clear zone. Lack of design standards and commercial products for implementation are main obstacles in roadside safety on all highway facilities in China*

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A recent car crash with this type of sign support on the roadside of the freeway killed one occupant; the sign support did not sustain any damage

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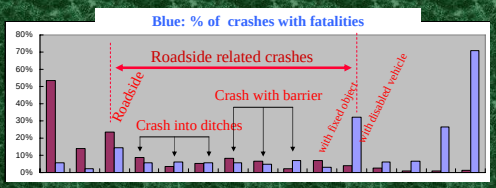
What are the problems?

- **Roadside Safety**



Type of Crash

The significance of roadside design has not been fully addressed in China

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What are the problems?

Driver behavior

Unsafe driver behavior is commonly considered the result of rapid motorization development. Fatigue, ignoring traffic control, and erratic lane changing maneuver are very common

Trucking industry is highly unregulated, and loosely enforced even with the limited governing regulations

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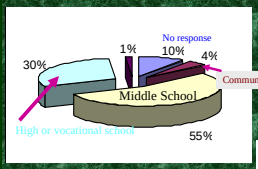
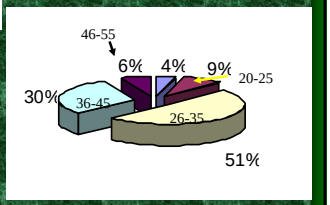
Truck driver education level



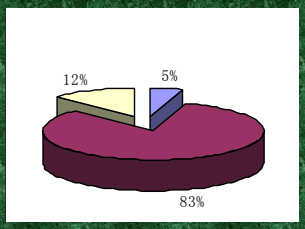
Truck driver age distribution



If you suddenly realize that you just missed the intended exit ramp, what would you do?

A.Go to the next exit ramp (83%)

B. back up to the missed exit ramp (12%!!!)



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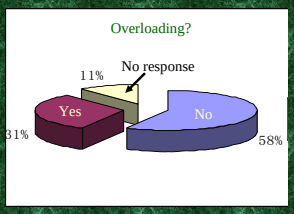
What are the problems?

Overloading - few truck drivers admit overloading but their frequent brake pad change clearly demonstrates the problem



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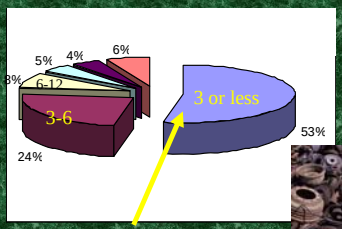
How often do you change the brake pad ? (number of months)



53% said they replace brake pads every three months or less!!!

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What are the problems?

Lake of coherent collaboration between highway agency (under Ministry of Communication) and enforcement agency (under Ministry of Public Security)

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Discussion

Safety problems at this freeway are not unique – they are quite common on freeways in China.

- *Narrow shoulders*
- *Poor barrier design*
- *Frequent vehicle mechanical problems*
- *Overloading trucks*
- *Poor driver behavior*
- *Lack of real time enforcement (because of narrow shoulder)*

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Common Problems Seen on Other Freeways in China

the barrier is mounted above a 15 cm curb and placed about 20 cm behind the face of the curb

Discontinuities: There are many isolated locations along the roadway where the continuous barrier is just stopped; there is no tension development so no redirection capability

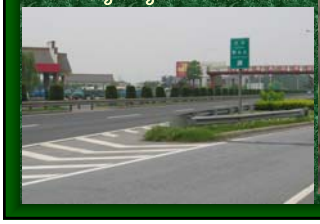
Common Problems Seen on other Freeways in China

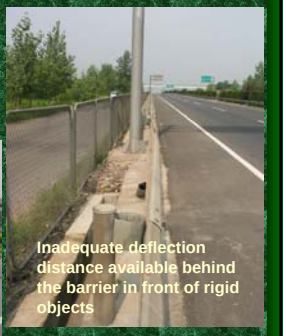
No transition between rigid and flexible barriers

Unsafe median opening

Common Problems Seen on other Freeways in China

When W-beam barrier is placed along both the left edge of the exit ramp and the right edge of the through lane of traffic, the barriers are brought together in a blunt end





Inadequate deflection distance available behind the barrier in front of rigid objects

Strategies for Safety Enhancement

From highway engineering perspective

- *Widening shoulder*
- *Rumble strip*
- *Breakaway sign support*
- *Proper barrier design*
- *Redesign or eliminate curb*
- *Crash cushion*

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However, highway improvements can't solve all problems, most specially driver behavior.

More work needs to be done from other important perspectives:

- Driver education (the key in highway safety improvement)
- Persistent enforcement on overloaded trucks (may lead to short-term negative impact on local economical development, but long-term benefits are tremendous)
- Collaboration between government agencies
- Emergency medical service
- Law and regulation
- Regional economic development policy

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Speed differential problem

- Bad driver behavior
- Overloaded trucks
- Poor truck condition
- Economic development policy
- Lack of real time enforcement

Deadly rear-end crash

It is necessary to target all above areas to solve speed differential problem - one of the biggest hazards in highway safety

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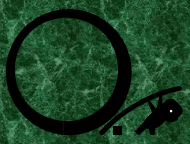
Where are we?

- No panacea, no overnight solution to the problems
- System approach for complex problems



•Need leadership with long-term vision to combating highway safety problems.

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Compare to other types of roadways, freeways in general have the highest design standard. Because of that, a freeway should be, and is, the most efficient and safest type of highway.

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Acknowledgement

The research group putting the puzzles together

Mr. William Fitzgerald, an expert on roadside safety (former FHWA specialist)

Please email to: xsun@louisiana.edu, xdsun@bjut.edu.cn if you have questions or suggestions.

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