SURF 2012
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7th symposium on pavement surface characteristics

AN INNOVATIVE ROUTINE METHODOLOGY FOR ROAD SURFACE CONTROL

Keizo KAMIYA, NEXCO Research Institute, Japan
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Andreas Ueckermann, Technical University of Aachen, Germany

A ROUTINE MONITORING METHOD USING WEIGHTED LONGITUDINAL PROFILE

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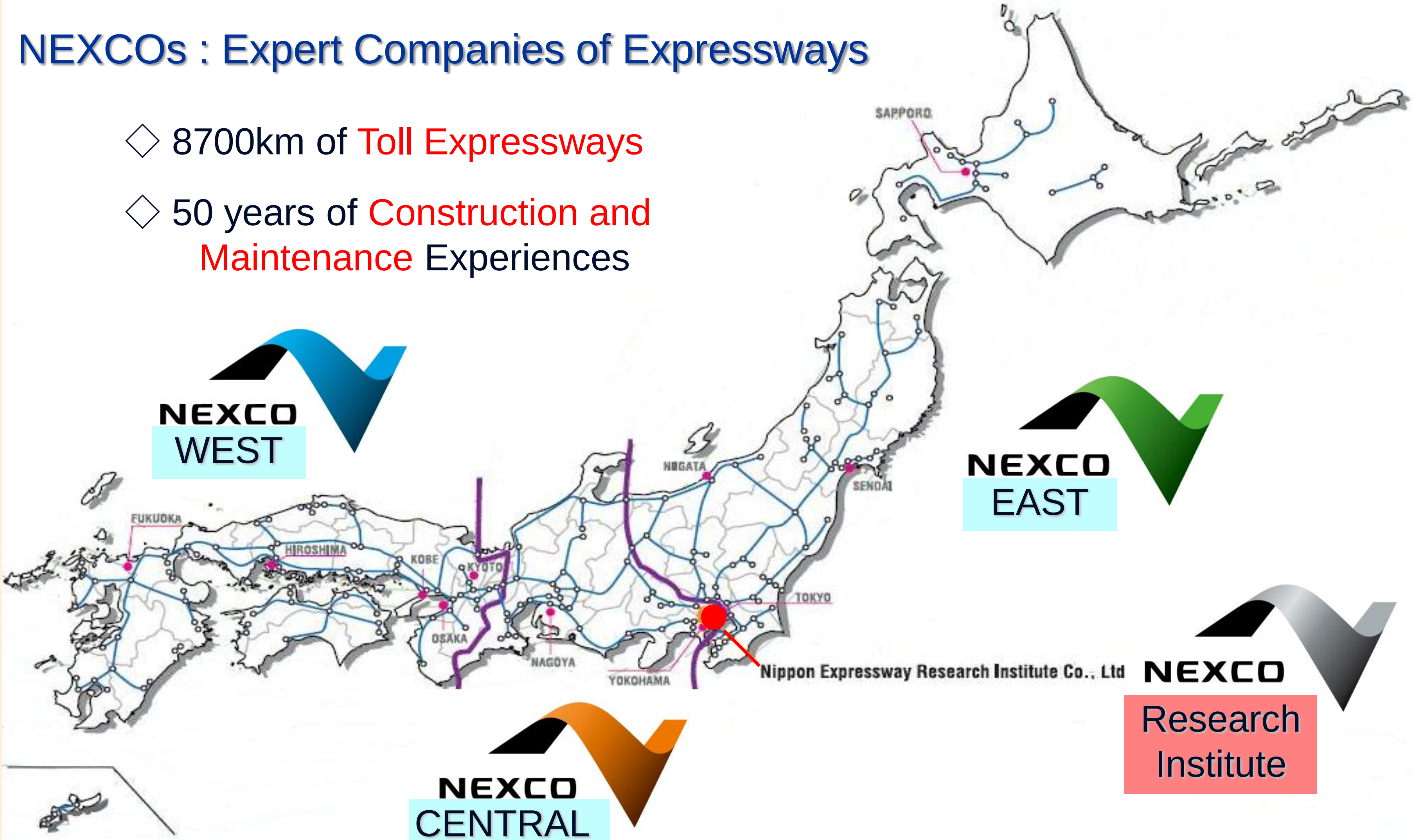
NEXCOs : Expert Companies of Expressways

- ◇ 8700km of Toll Expressways
- ◇ 50 years of Construction and Maintenance Experiences



NEXCO WEST

NEXCO EAST

NEXCO CENTRAL

NEXCO Research Institute

NEXCO: Nippon Expressway Company Ltd.

Objectives of the joint study

- **To identify the relation between road surface distress and weighted longitudinal profile**
- **To clarify accuracy of a mobile profiling system, named STAMPER**
- **To examine applicability of WLP for a routine monitoring, using STAMPER**

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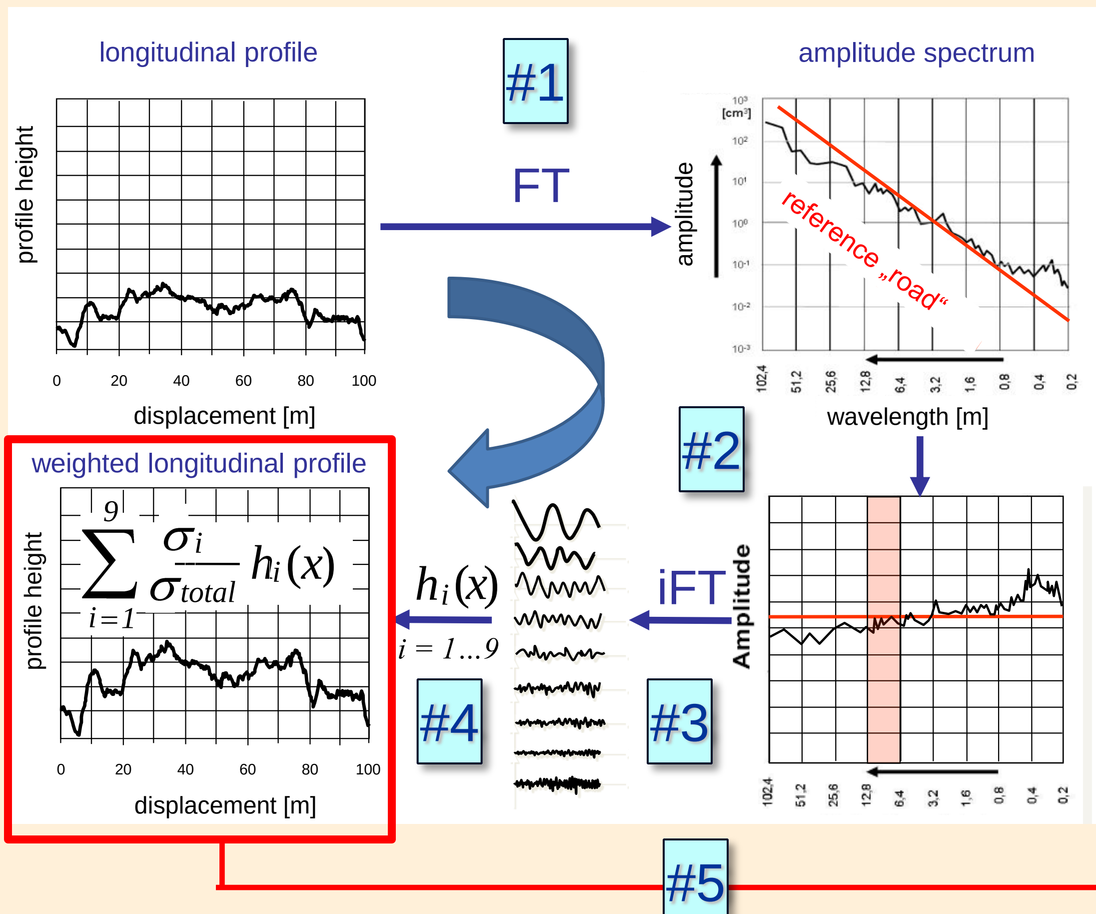
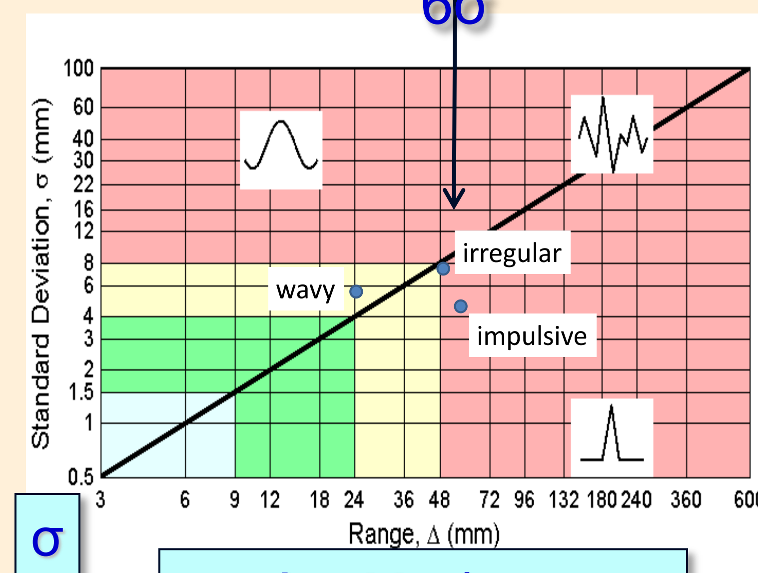
Weighted Longitudinal Profile, by Maurer et al. (SURF 2008)

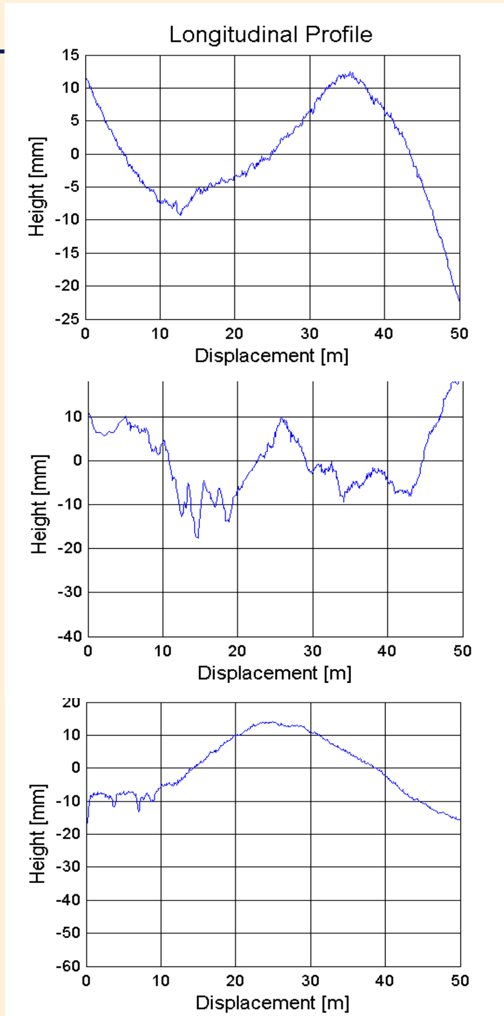


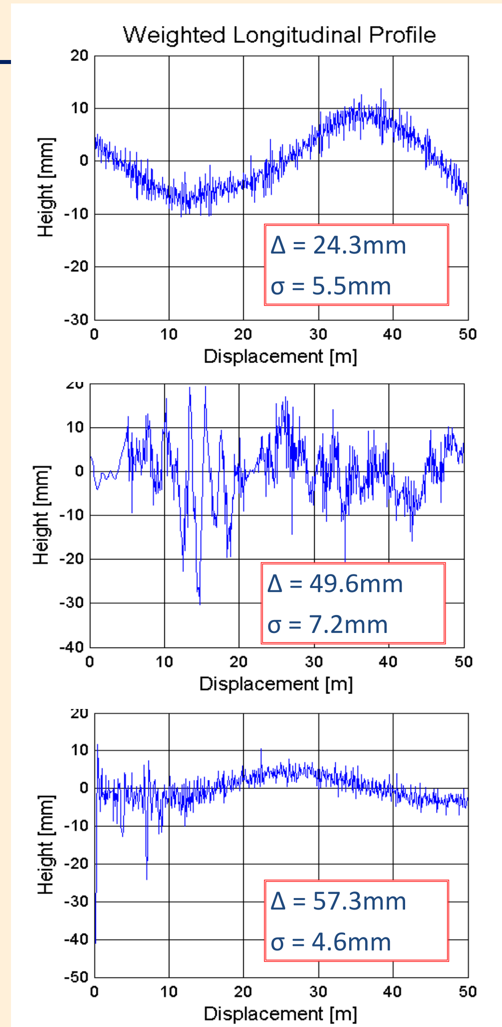
Gausian unevenness line (irregular) : Δ = 6σ



Δ = Maximum difference in height

Original profile and WLP





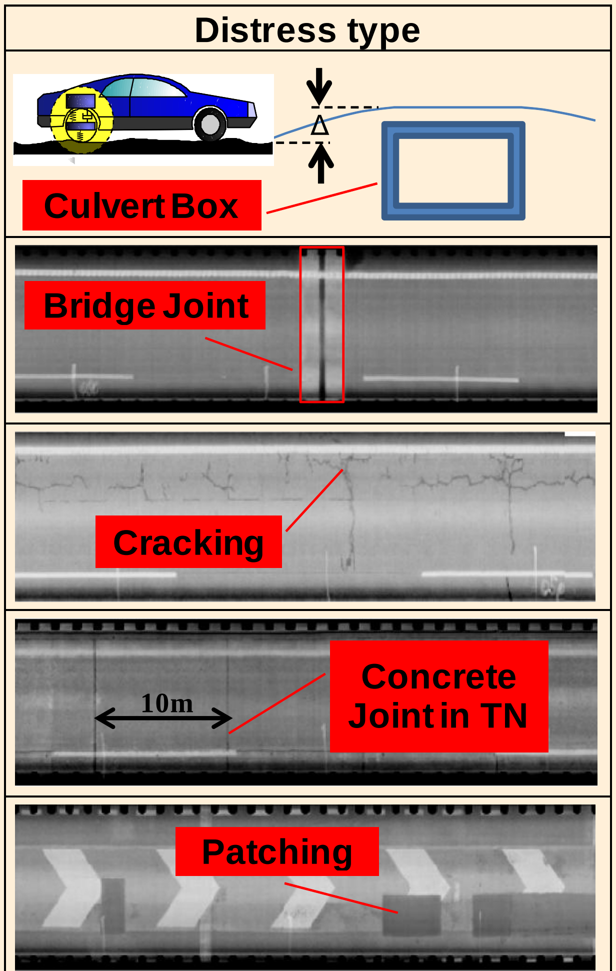
What kind of distress?

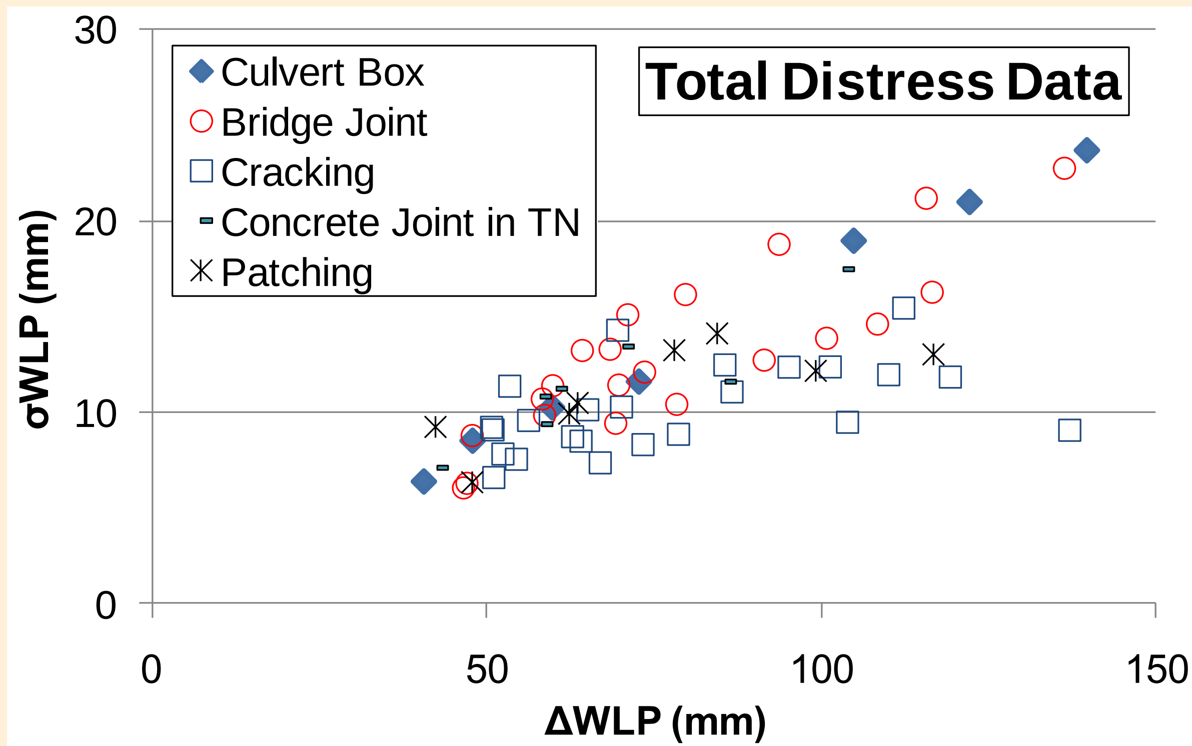
Wavy pattern
$\Delta \ll 6\sigma$

Irregular pattern
$\Delta = 6\sigma$

Impulsive pattern
$\Delta \gg 6\sigma$

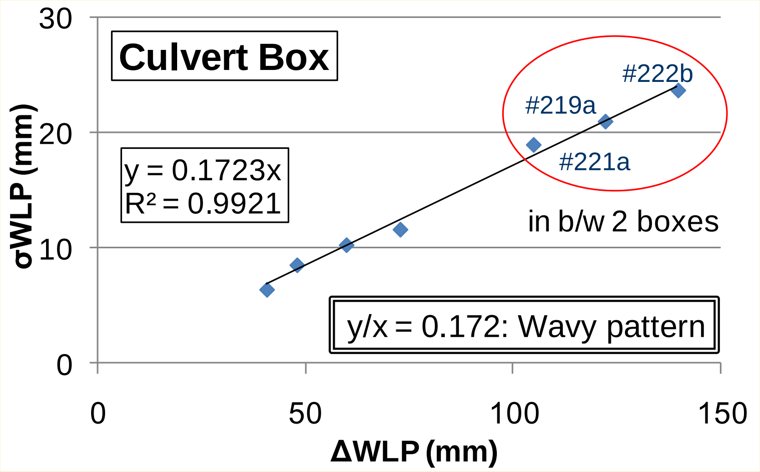
Road Surface Distress and WLP using Japanese data (IRI ≥ 3.5)

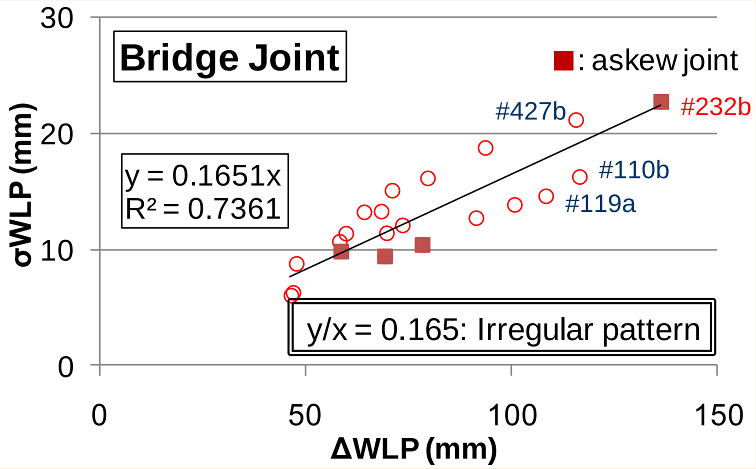


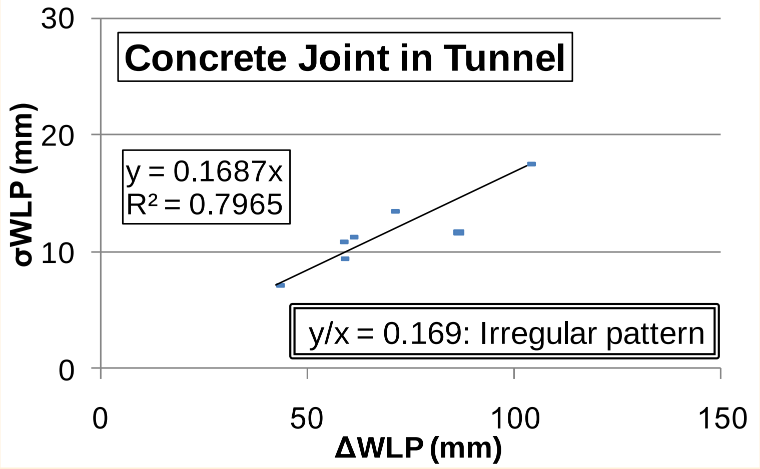


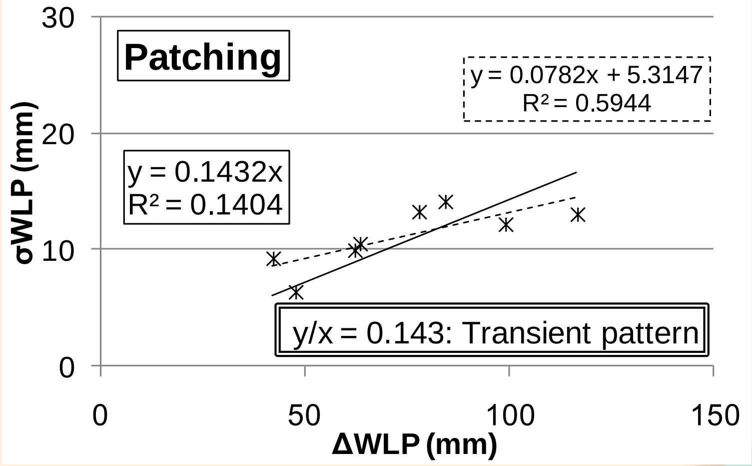
Distress type and WLP

Highly Correlated

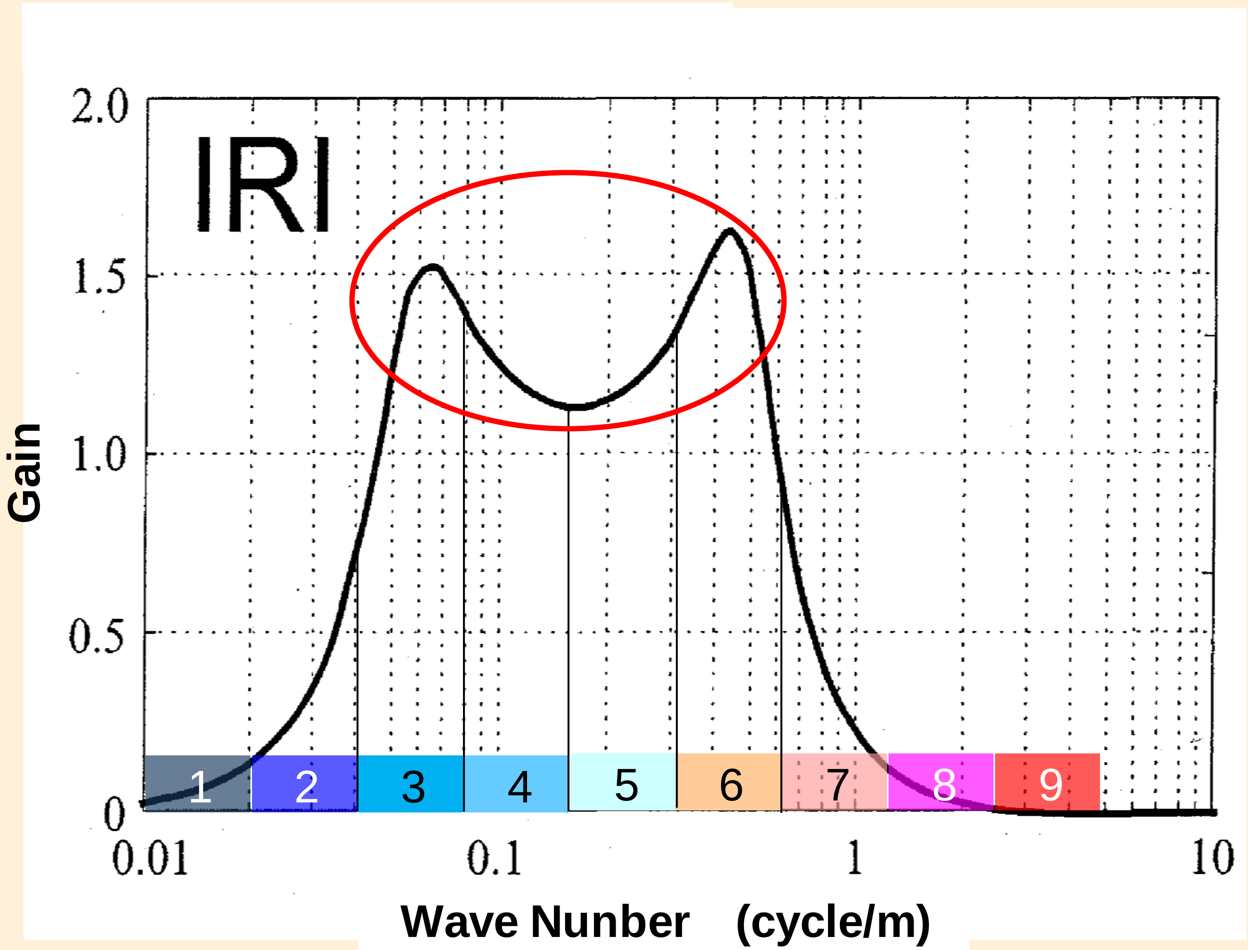




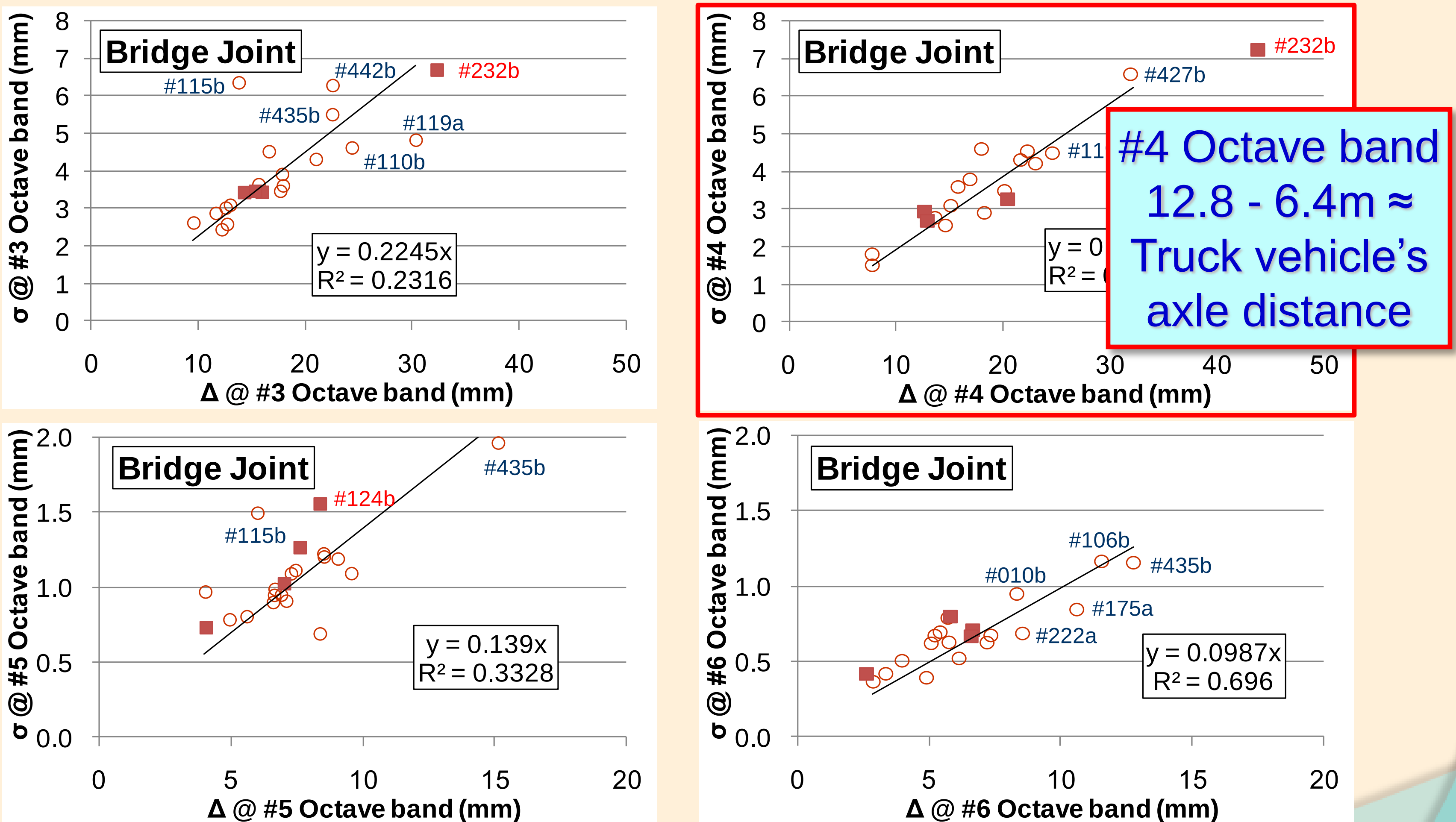




IRI Gain and Octave band



Δ and σ for Octave bands #3-#6 from Original profile



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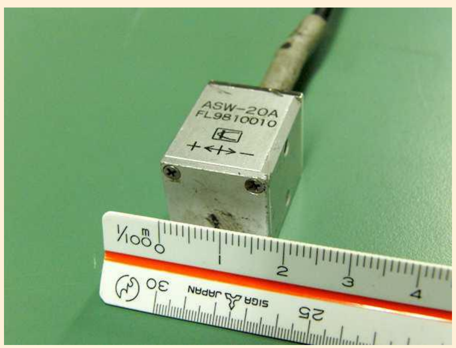
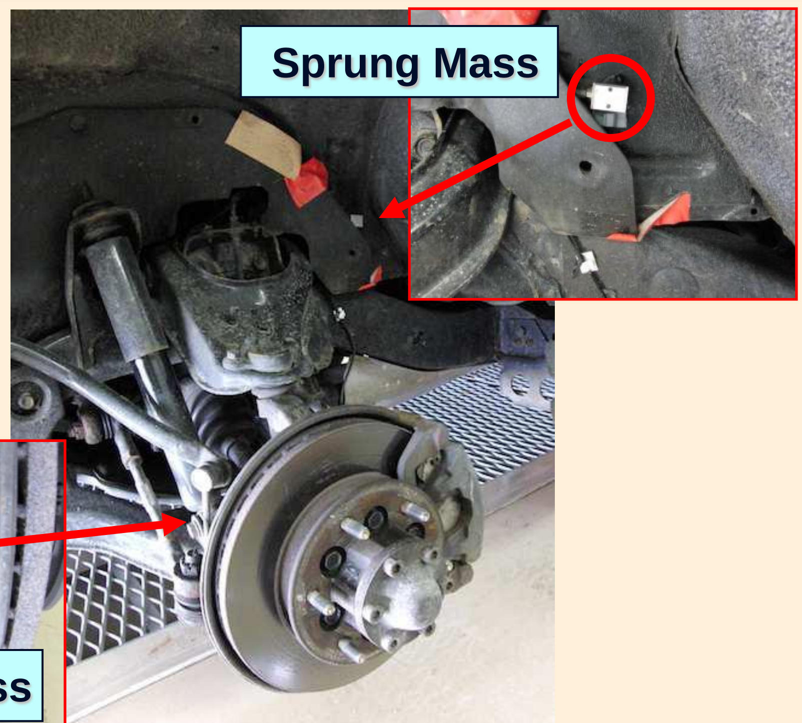
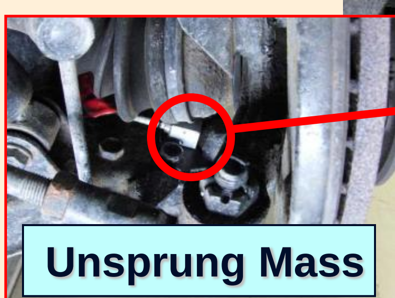
A Mobile Profiling System by Prof. Kawamura, Kitami Inst.

System with Two Accelerometers for Measuring Profile, Enabling Real-time data collection

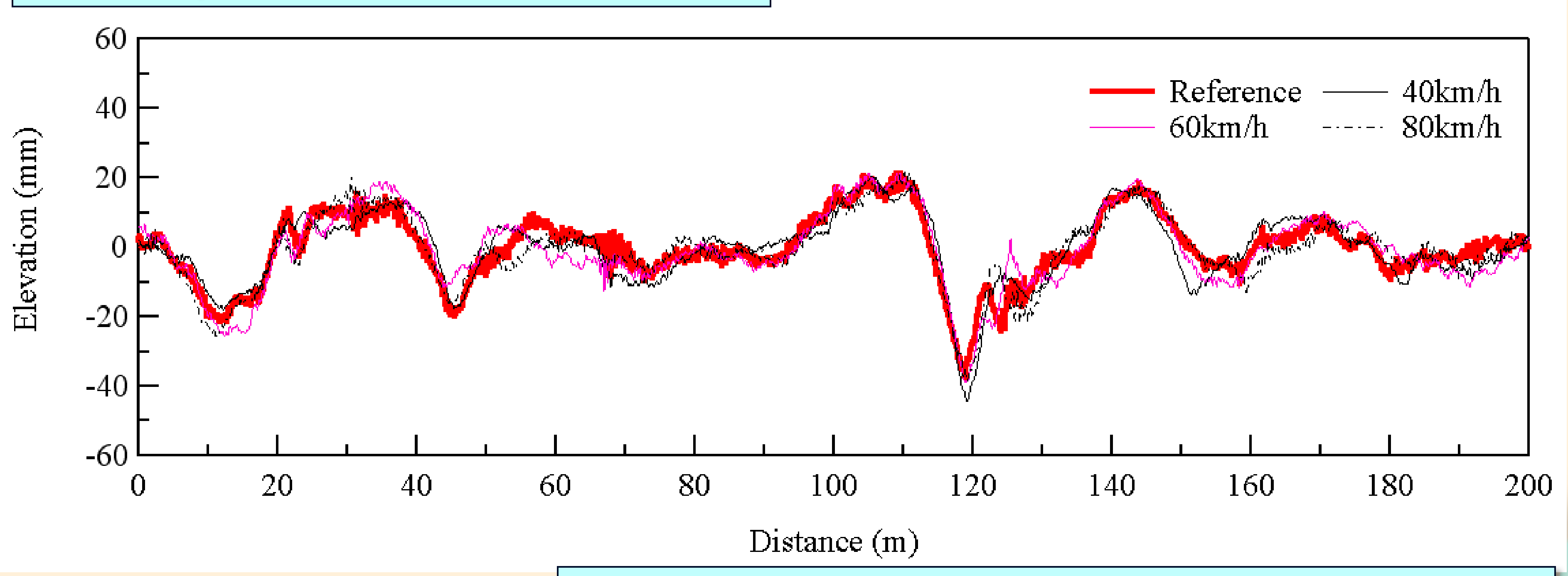






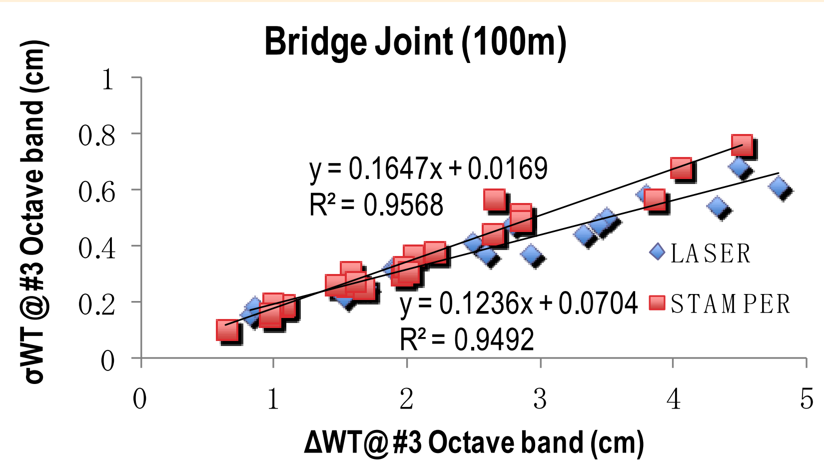
Back-calculated profile (STAMPER) and Reference profile

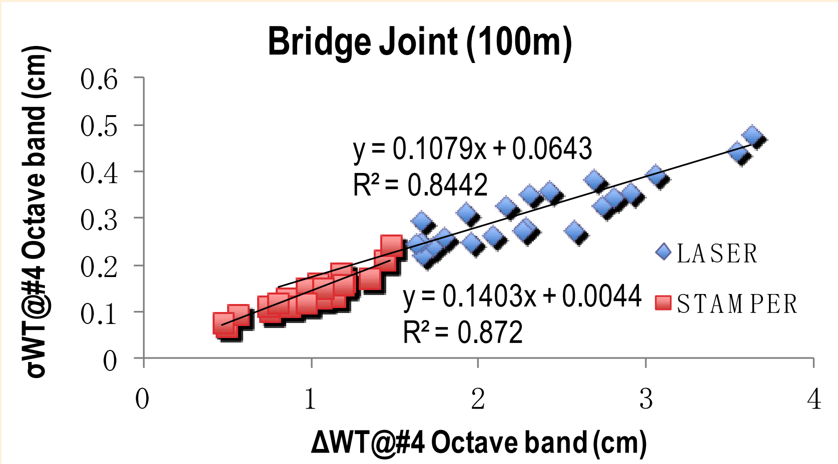
Band pass filter 0.5 - 50m

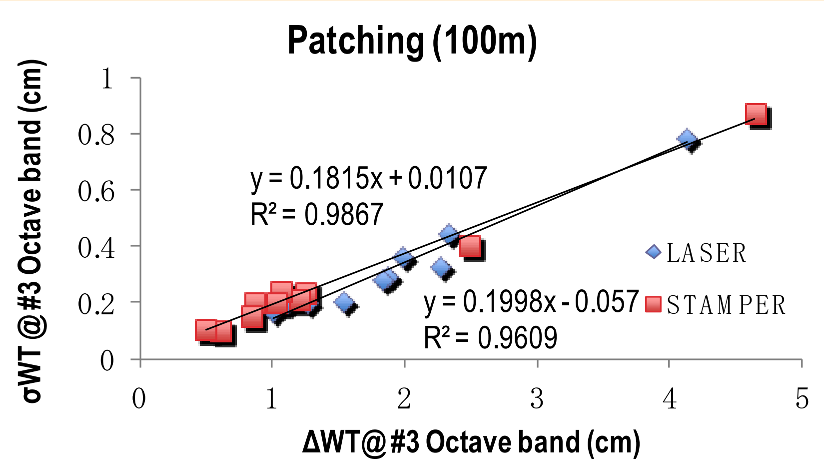


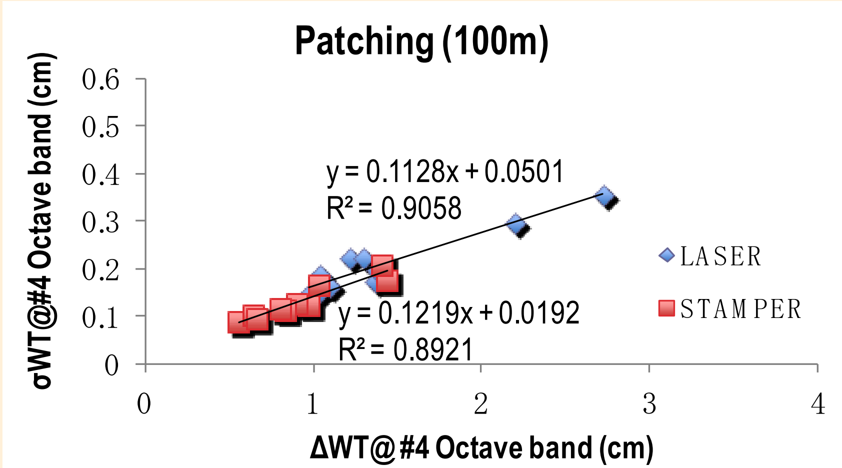
STAMPER's profile data is reliable.

Back-calculated profile (STAMPER) and LASER profile: Compatible









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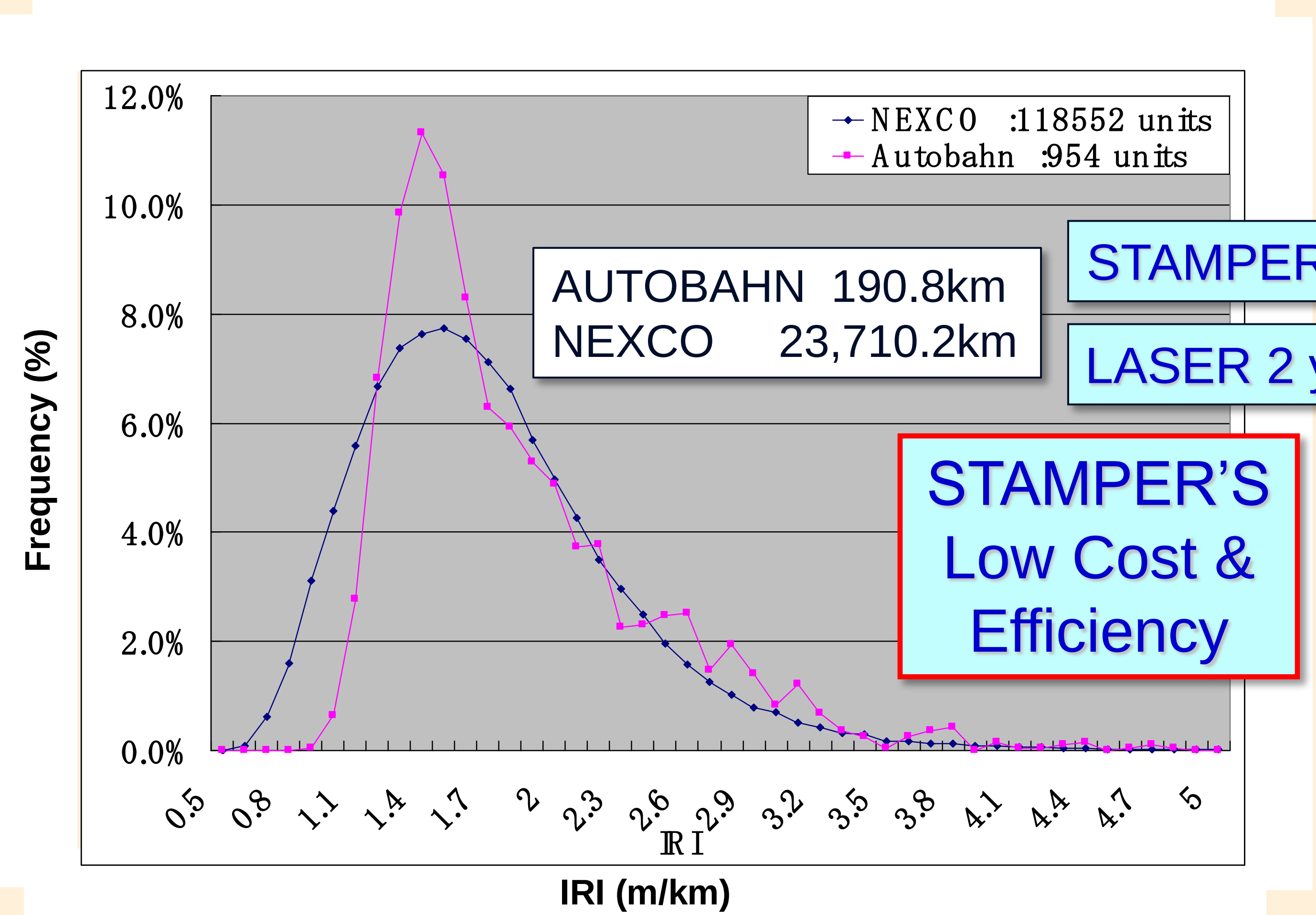
STAMPER study on AUTOBAHN (2007)

Section ID	Route	Pavements	Section Length (m)
#1	Autobahn	Asphalt	2,700
#2	Autobahn	Asphalt	43,100
#3	Autobahn	Asphalt	10,400
#4	Autobahn	Concrete	10,600
#5	Autobahn	Concrete	10,200
#6	Autobahn	Concrete	10,300
#7	Autobahn	Concrete	3,300
#8	Autobahn	Concrete	10,300
#9	B Line	Asphalt	12,200
#10	Autobahn	Concrete	12,700
#11	B Line	Concrete	14,100
#12	Autobahn	Asphalt	29,600
#13	Autobahn	Concrete	19,800
#14	Autobahn	As on Con	10,600
#15	Autobahn	As on Con	5,000
#16	Autobahn	As on Con	8,400
#17	Autobahn	Asphalt	3,800

IRI on AUTOBAHN & NEXCO Motorway



STAMPER 5 days

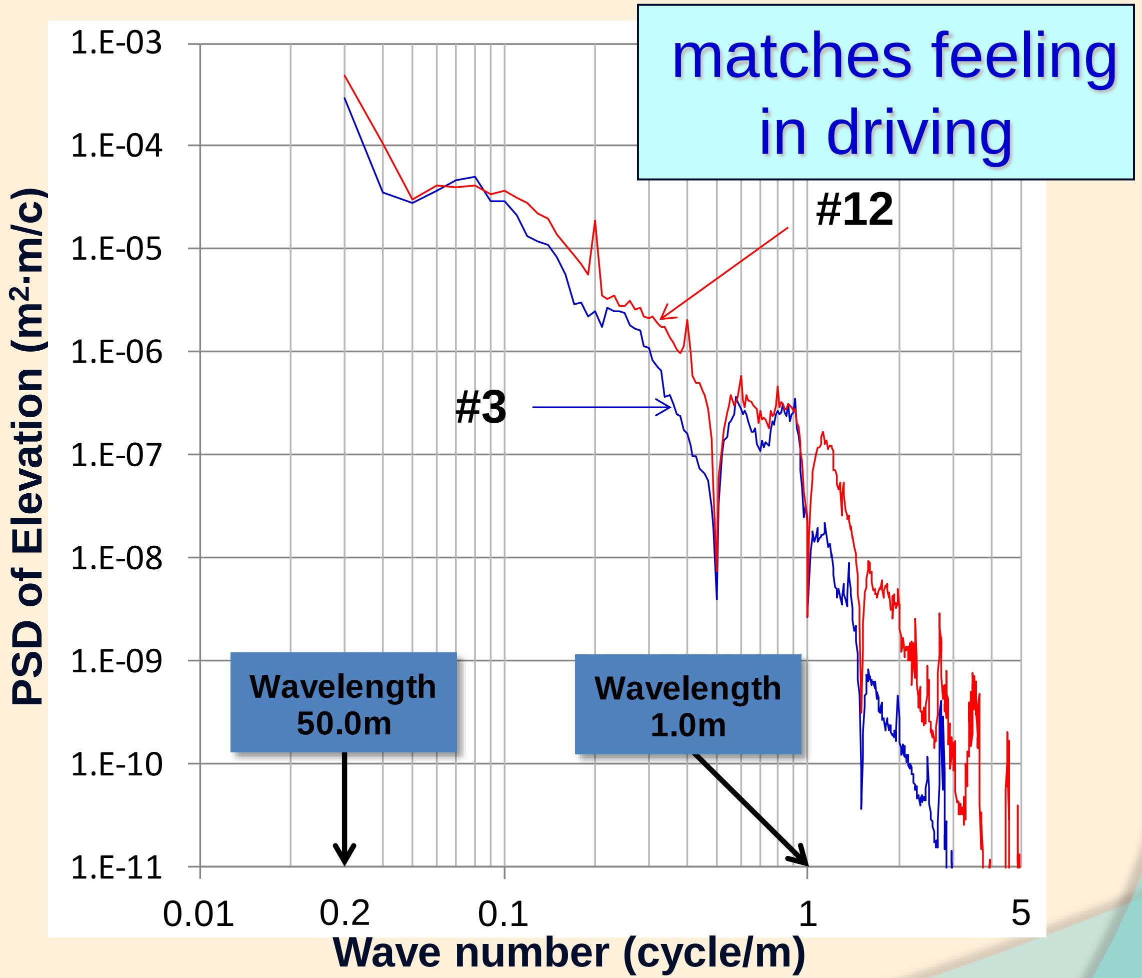
LASER 2 years

STAMPER'S Low Cost & Efficiency

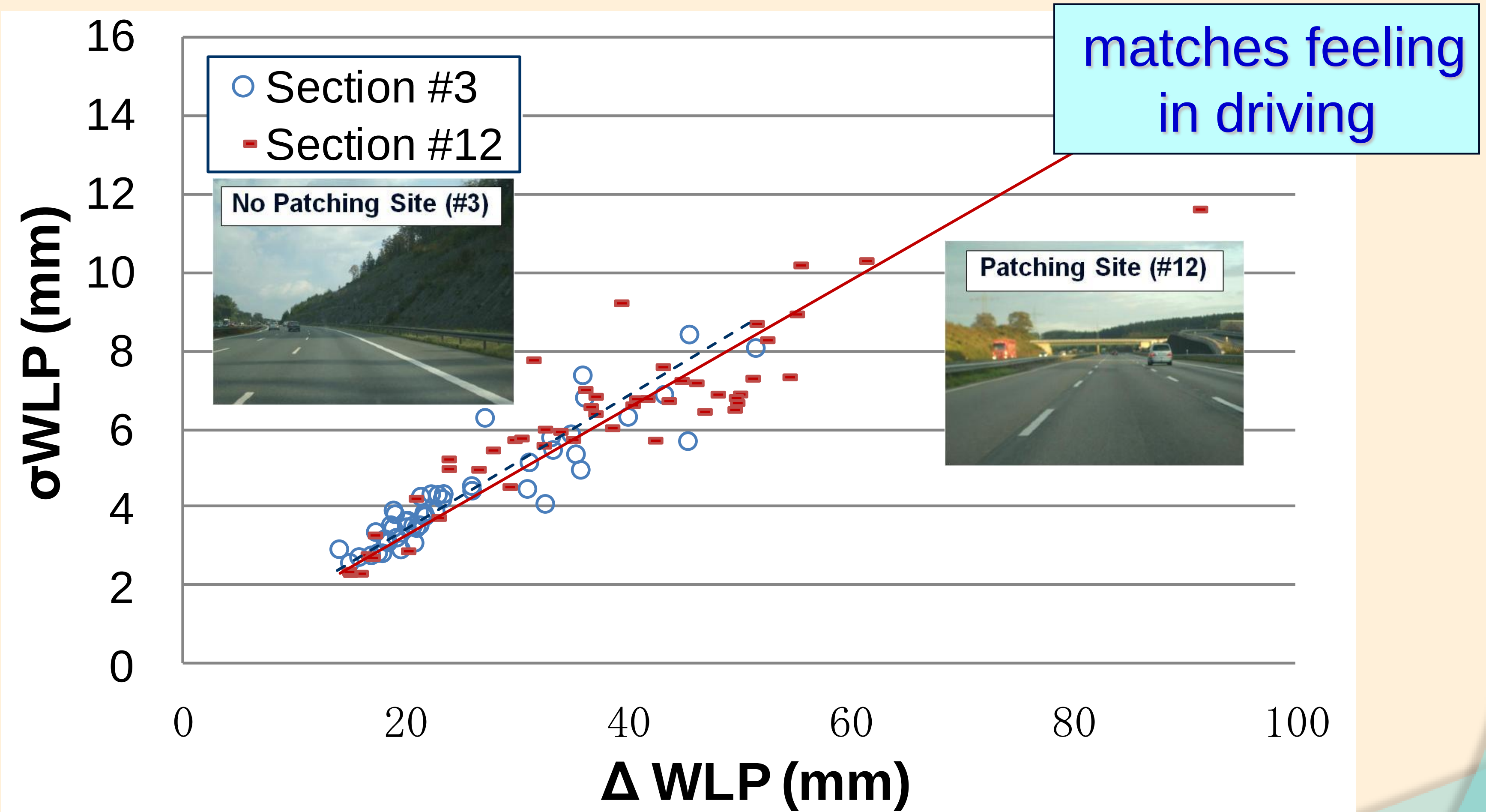
PSD on AUTOBAHN asphalt sections

Patching Site (#12)

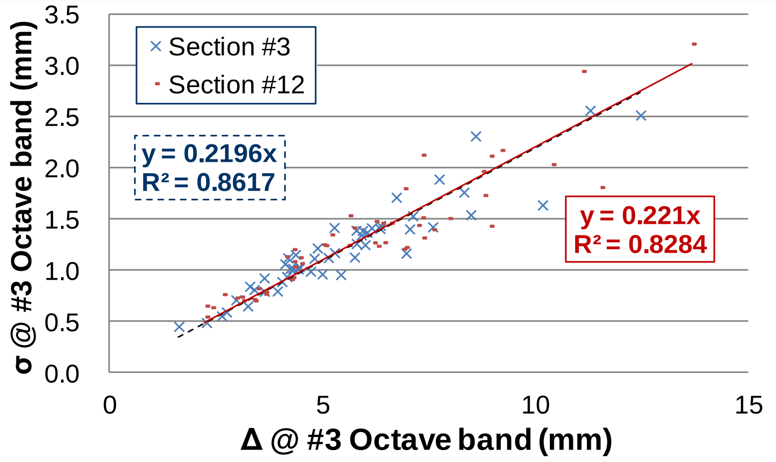
No Patching Site (#3)

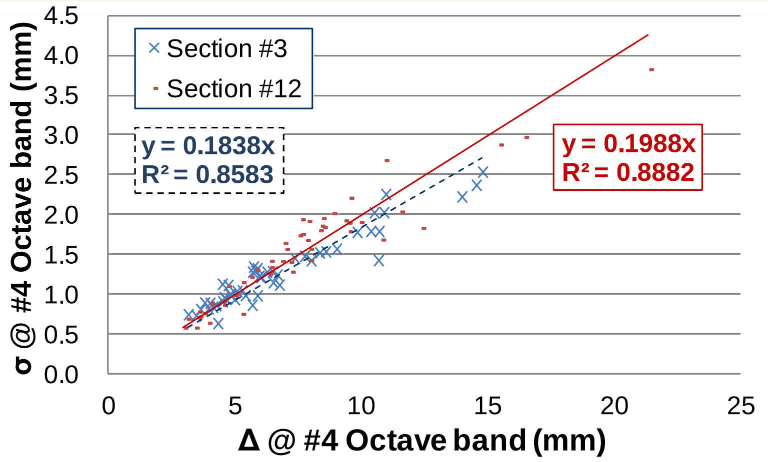


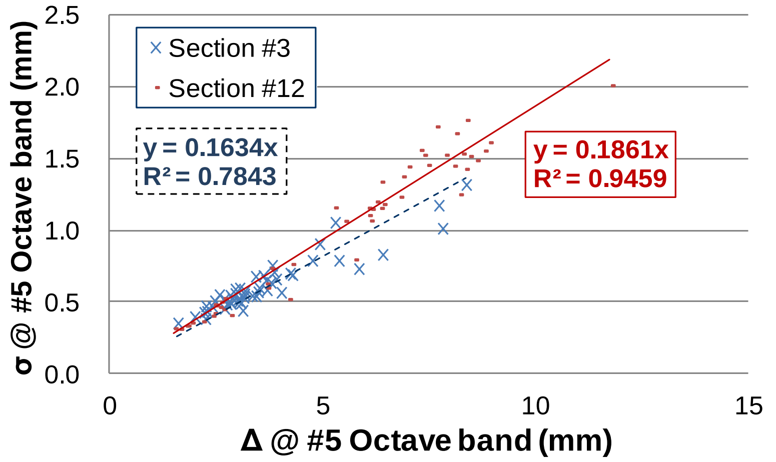
Distributions of σWLP and ΔWLP

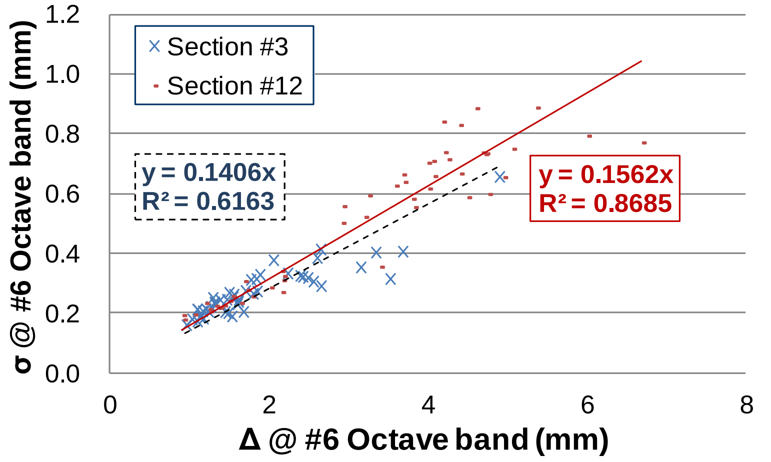


Δ and σ for every Octave band from Original profile

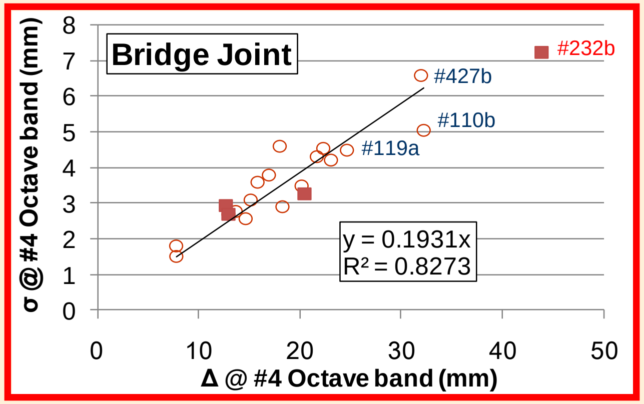


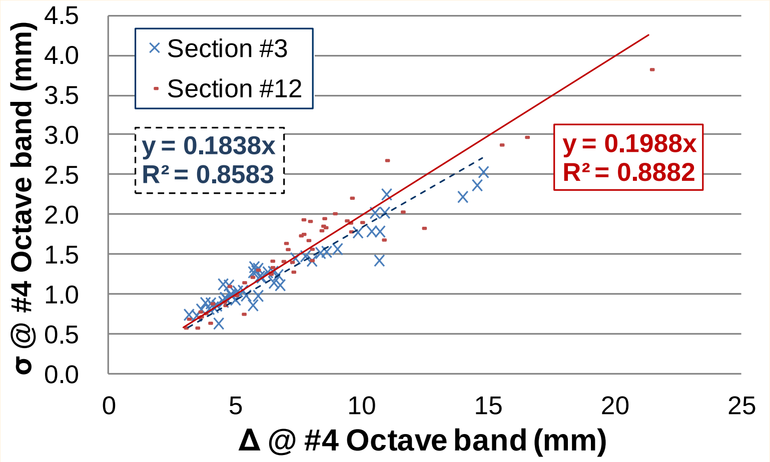


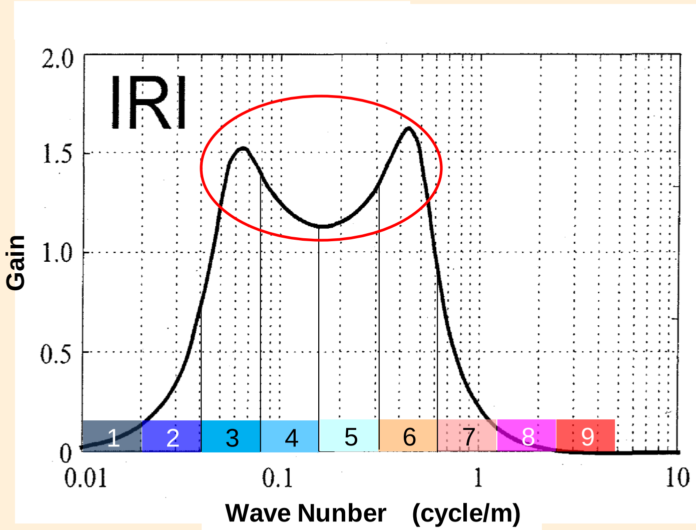


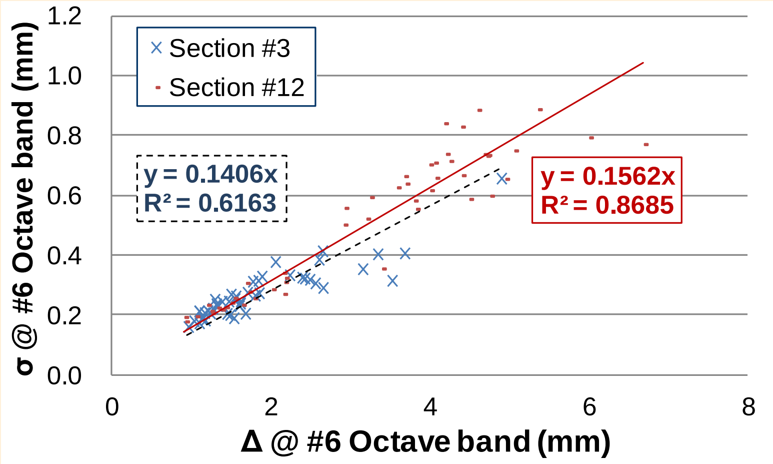


Octave band #4 is generally important, while band #6 can differentiate when Δ is lower.





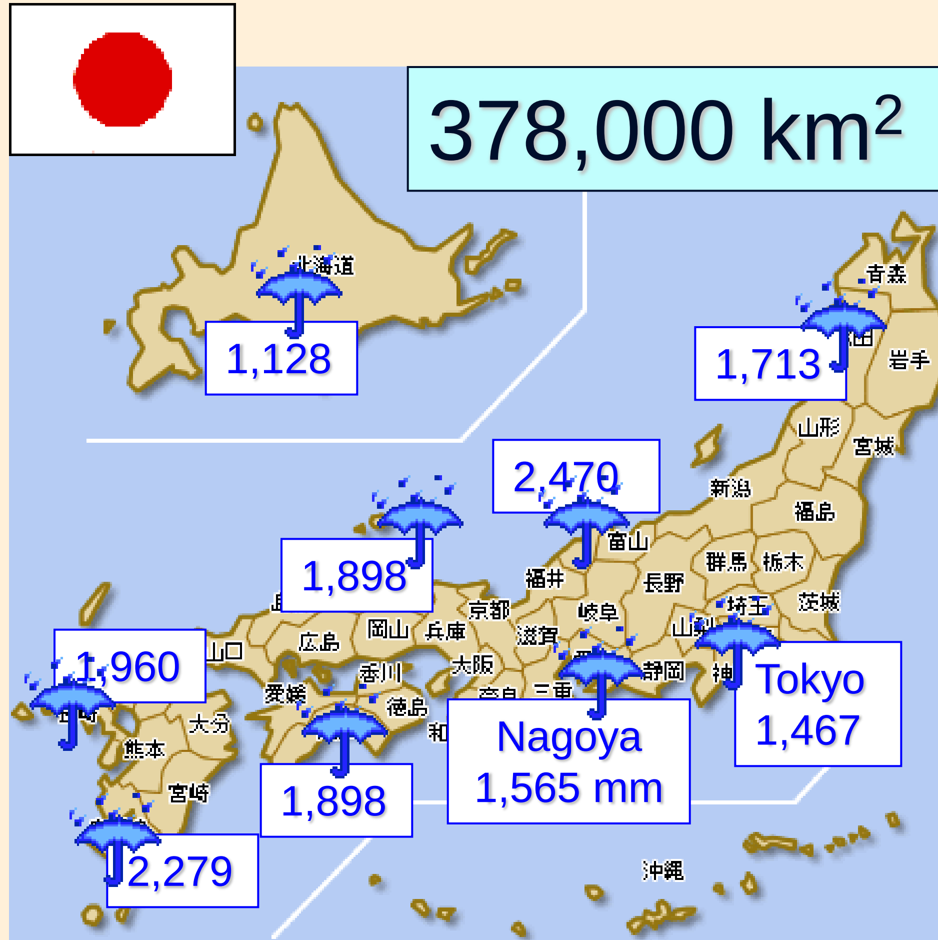




Summary and Conclusion

- **A correlation between every surface distress type and WLP was found.**
- **STAMPER's back-calculated profile data is compatible with laser profile data.**
- **Applicability of WLP using STAMPER was confirmed.**
- **WLP using STAMPER is recommended as a routine monitoring method.**

City	Annual Rainfall
Seoul	1,343 mm
Jakarta	1,903 mm
Bangkok	1,530 mm
Hong Kong	2,360 mm
Manila	1,715 mm
Kula Lumpur	2,390 mm
Zurich	1,120 mm
New York	1,123 mm



70% Land: Mountains

Source: Ministry of International Affairs Communications


25% Bridge & Tunnel

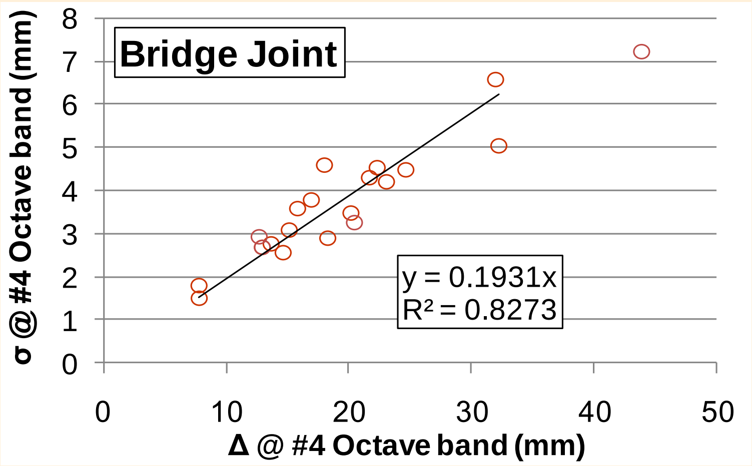
1,445km - 1,545 Tunnels

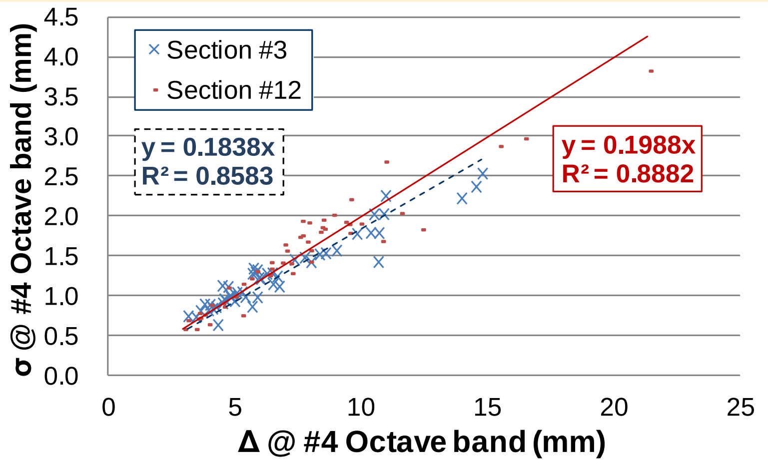
1,250km - 13,500 Bridges

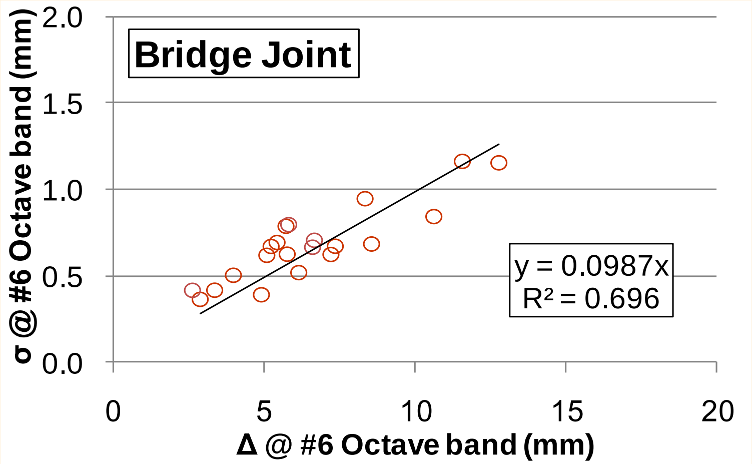

75% Bank & Cut

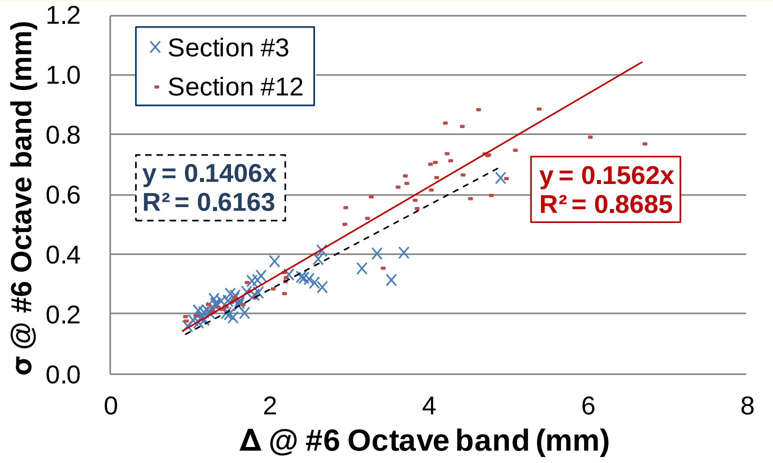
Many high bank sites

Many big cut slopes


Bridge Joint
y = 0.1931x
R² = 0.8273
σ @ #4 Octave band (mm)
Δ @ #4 Octave band (mm)
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50

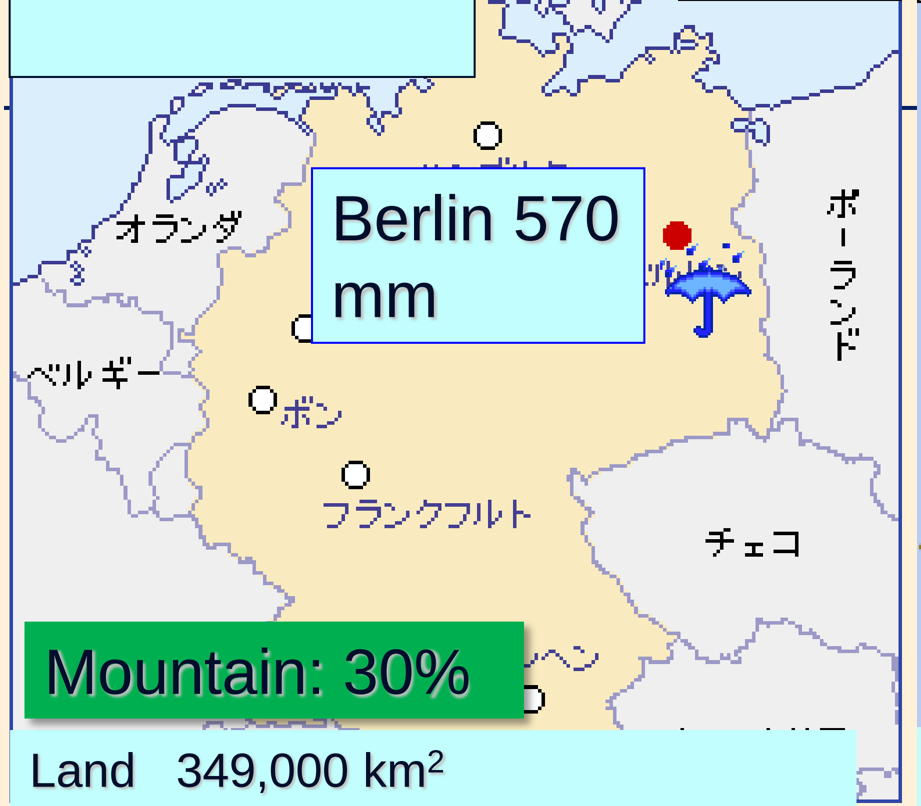

Section #3
Section #12
y = 0.1838x
R² = 0.8583
y = 0.1988x
R² = 0.8882
σ @ #4 Octave band (mm)
Δ @ #4 Octave band (mm)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
0
5
10
15
20
25


Bridge Joint
y = 0.0987x
R² = 0.696
σ @ #6 Octave band (mm)
Δ @ #6 Octave band (mm)
0.0
0.5
1.0
1.5
2.0
0
5
10
15
20


Section #3
Section #12
y = 0.1406x
R² = 0.6163
y = 0.1562x
R² = 0.8685
σ @ #6 Octave band (mm)
Δ @ #6 Octave band (mm)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
2
4
6
8

Country Information

82 Million People

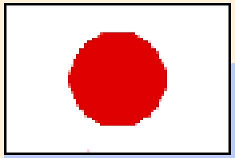


Berlin 570 mm

Mountain: 30%

Land 349,000 km²

Forest 111,000 km²



128 Million People

Mountain: 70%

Tokyo 1500 mm

Land 365,000 km²

Forest 250,000 km²

Source: Ministry of International Affairs Communications

Critical Conditions

Less plain areas (70%: Mountains)

No alternative routes
Heavy traffic loads

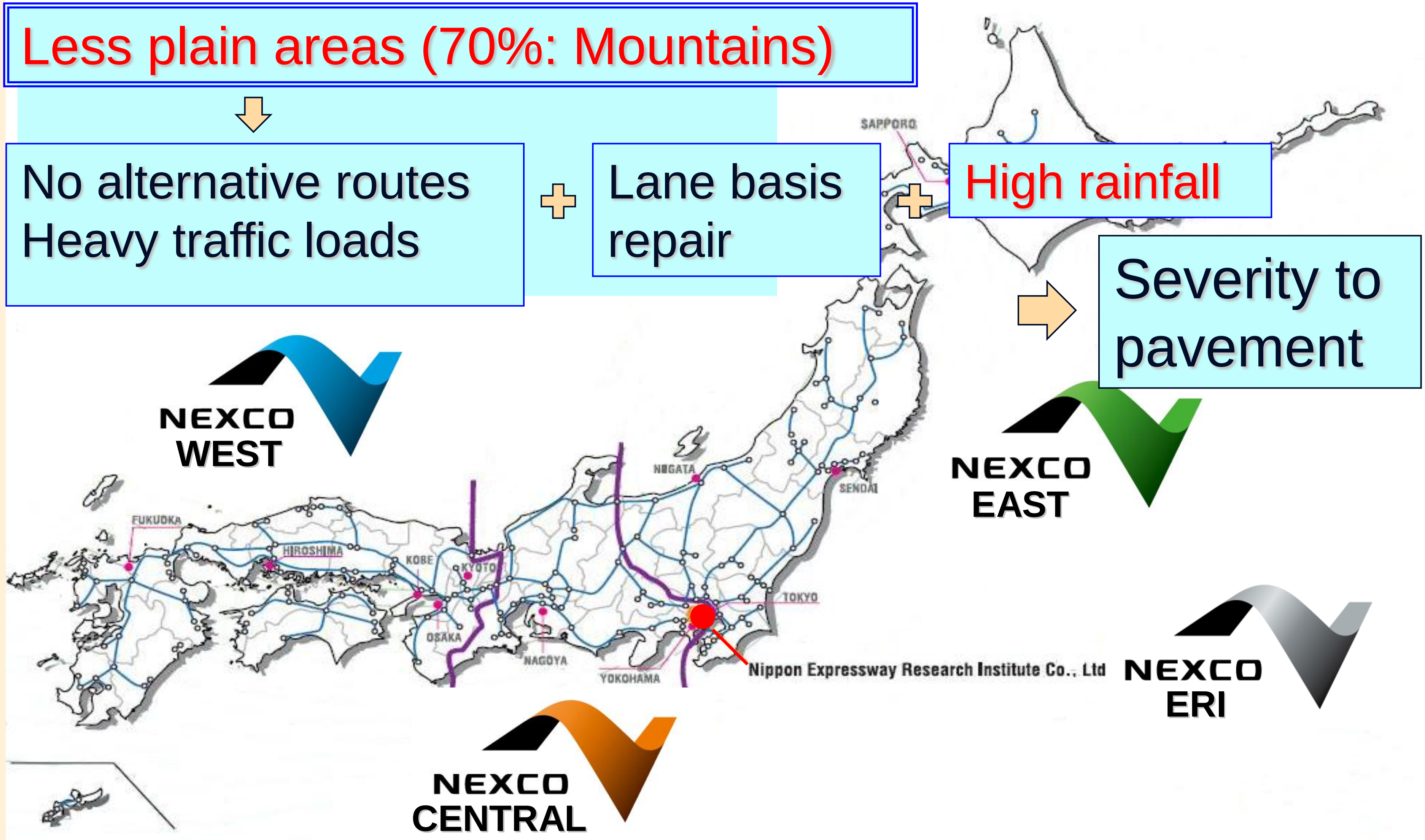
+

Lane basis repair

+

High rainfall

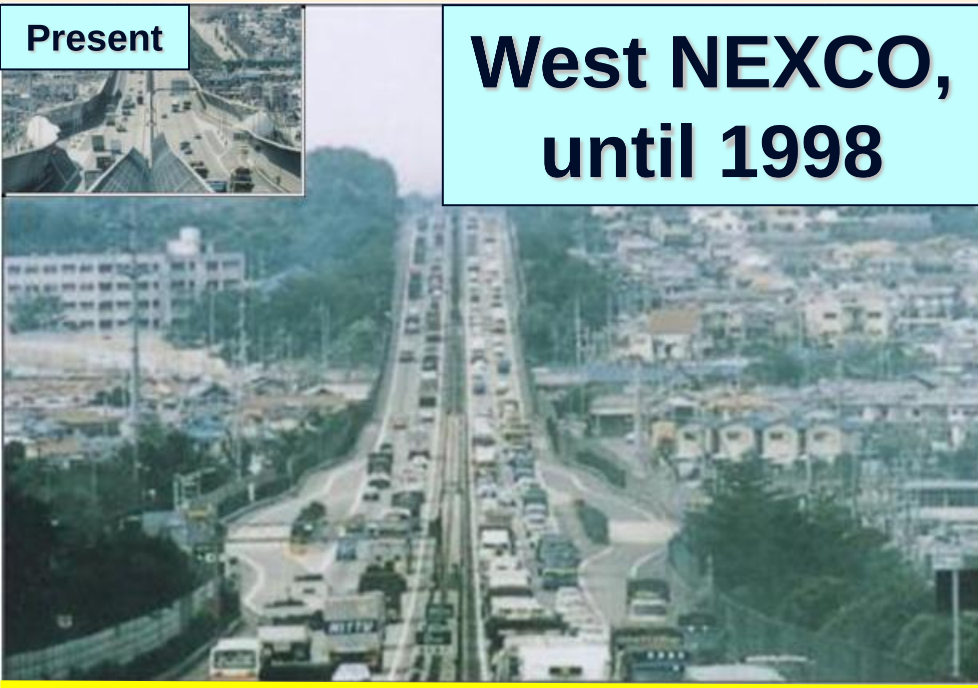
Severity to pavement



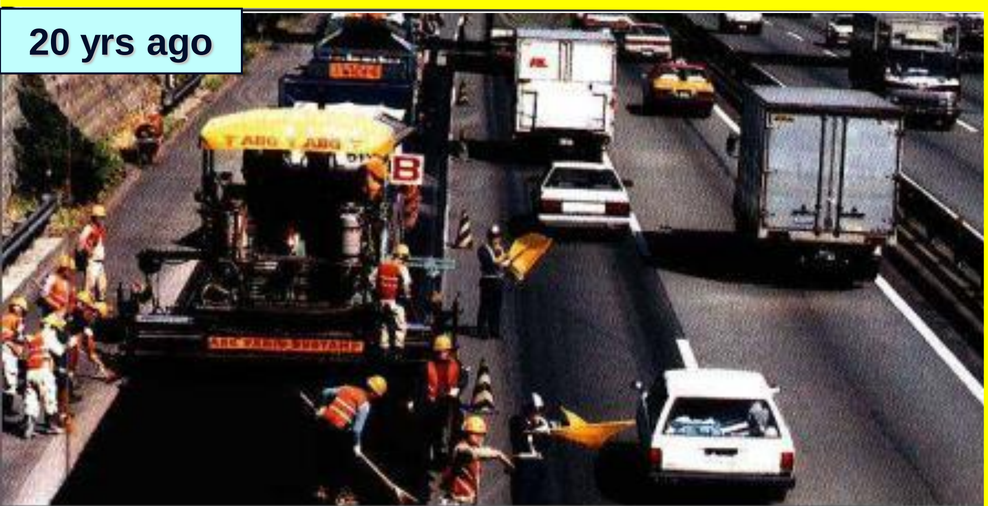
NEXCO: **N**ippon **Ex**pressway **Co**mpany Ltd.

West NEXCO, until 1998

Present



20 yrs ago



Autobahn A9 in 2007