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FAA Research on Runway Intersection Grading Criteria

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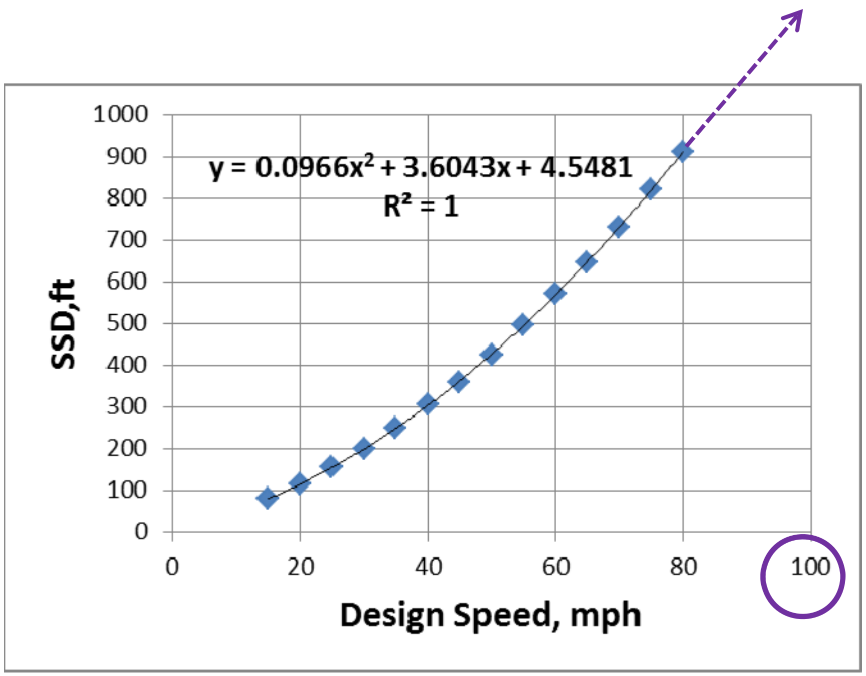
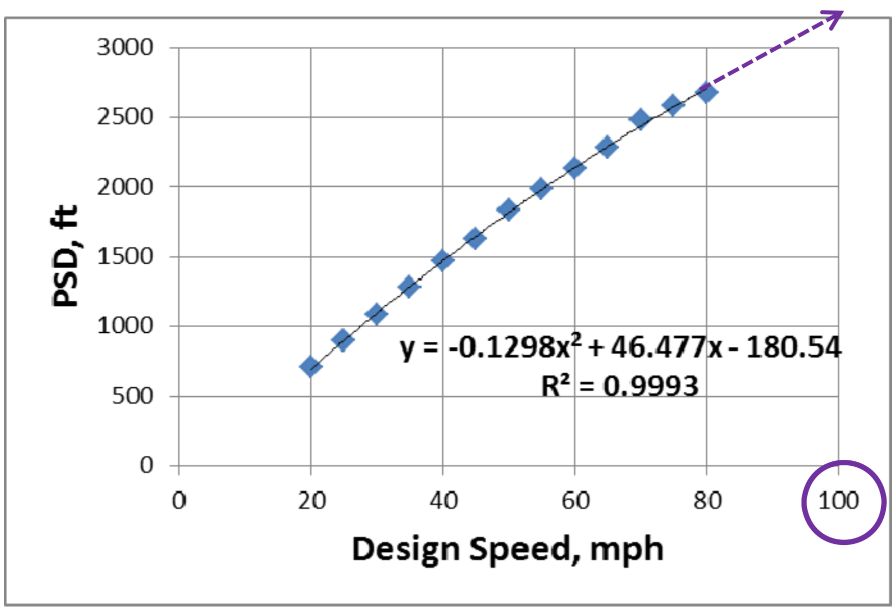
Objectives

- Needs to evaluate runway safety at runway intersections, as well as their ride quality.
- Review vertical sight distances, drainage, and roughness indices at runway intersections.
- Review current conditions of in-service pavement surface at runway intersection area.
- Consider gear configurations from multiple aircraft types including wide body to find critical zone in the intersection areas.

Vertical Sight Distance

- AASHTO “Policy on Geometric Design of Streets and Highways”
- SSD: 1,331’ at 87 kn (=100mph) 2,719’ at 130 kn (=150mph)
- PSD: 3,169’ at 87 kn (=100mph) 3,871’ at 130 kn (=150mph)





Pavement Surface Drainage and Roughness

- Any pavement surface drainage issues are directly related to runway safety. Factors like flow path, surface texture, surface slope, and rainfall intensity would impact on the water depth on the pavement.
- Only longitudinal and transverse pavement surface slopes are considered from the factors.
- FAA Advisory Circular 150/5320-5D, “Airport Drainage Design”.

AC150/5320-5D “Airport Drainage Design”

- Defines a minimum slope of 0.3 percent within 50 feet of the low point of curve in sag vertical longitudinal curve.
- For transverse slope, directly quotes roadway restrictions to use of a cross slope steeper than 2 percent on pavements with a central cross line.
- Referred from AASHTO Green Book, A Policy On Geometric Design of Highways and Streets, and UFC-3-250-01FA, Pavement Design for Roads, Streets, Walks, and Open Storage Areas.

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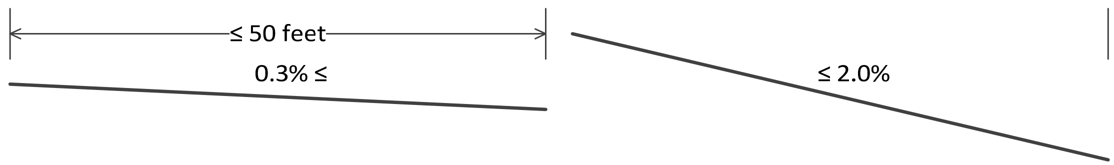
Slope Requirements in Current Standards

- In general, a minimum of 0.50 percent of pavement surface slope in any direction is applied to prevent any drainage problems for construction.
- Pavement roughness would be an issue at runway intersections with increasing slopes like 0.50 percent to improve drainage at pavement surfaces.

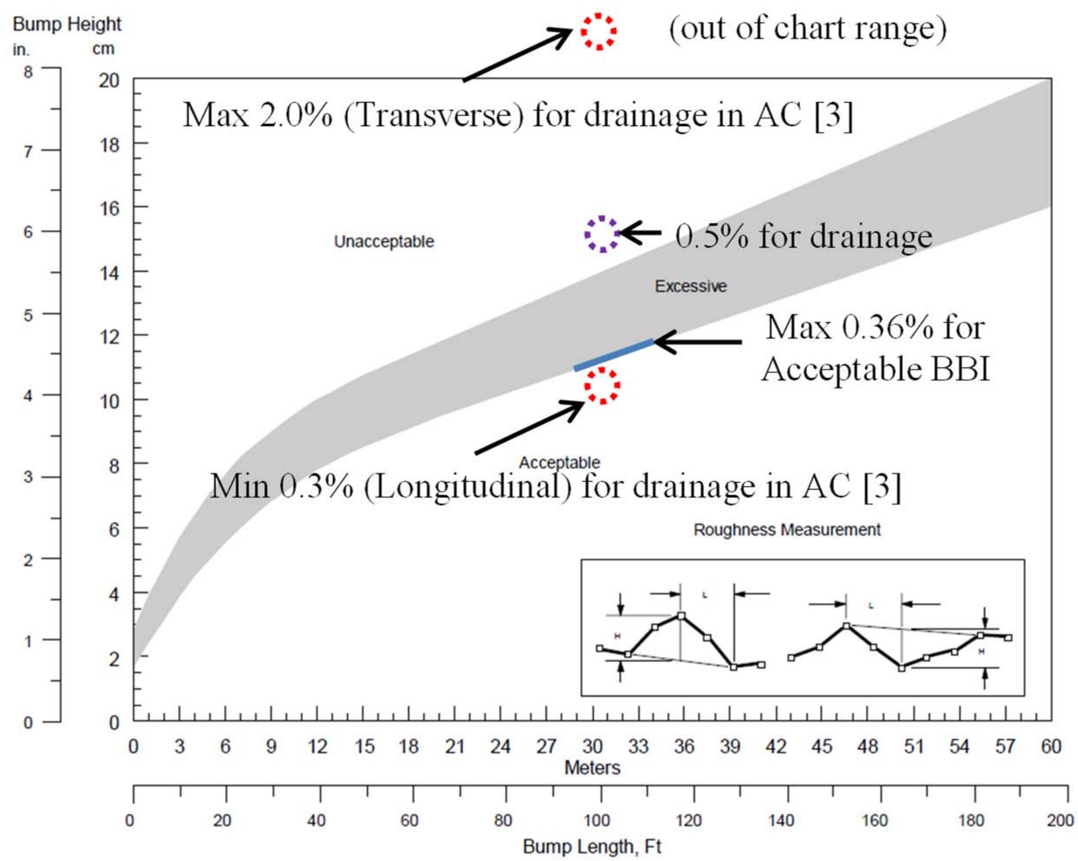
Standard	Longitudinal, %	Transverse, %
FAA AC150/5320-5D [3]	|0.3|≤	≤|2.0|
AASHTO Green Book	|0.3|≤	≤|2.0|
Boeing Bump Index	≤|0.36| (100 foot bump length)	NA

Slope Requirements in Current Standards



- FAA Longitudinal Slope Requirement [3]-

- FAA Transverse Slope Requirement [3] -



Suggested Profile Measurement Methodology (Preliminary)

- An inclinometer type walking profiler or lightweight inertial profiler is recommended. Typical inertial profiler at high speed measurement speed is not recommended.
- Imaginary longitudinal and transverse profile lines at at least six locations. They will be located at the centerline and the middle of crossing runway (transverse). Additional four lines (two for longitudinal and two for transverse) are recommended to equally divide the square shaped intersection pavement area.

Field Data Collection

- Both pavement types flexible and rigid were selected for in-service runway intersections using SurPro 2000 inclinometer.
- Runways 5-23 intersecting 10-28, 9R-27L intersecting 5-23, and 9-27 intersecting 1R-19L for airports A, B, and C, respectively. Airports A and B are located in Wet-Freeze, C is in the border of Dry, Wet-Freeze climate zone based on the FHWA LTPP program.
- Flexible runway pavement intersections (flexible – flexible) at airports A and B. Different pavement types (flexible – rigid) were used for the 9-27 and 1R-19L runways at airport C.
- Airport A: 10-28 (6,600’X150’) & 5-23 (4,225’X100’).
- Airport B: 9R-27L (5,004’X100’) & 5-23 (3,562X100’).
- Airport C: 9-27 (9,500’X150’) & 1R-19L (9,500’X150’).

Field Data Collection

- SurPro2000: speed at 1.0 to 1.2 mph for 10 inches sample spacing with Trimble GPS

Data Analysis – Critical Stress Area

- Based on the FAARFIELD aircraft library, gear configurations of multiple aircraft types including wide body are considered to identify relatively critical offsets for pavement roughness purposes.

Aircraft Type	Tire Offsets, inch					Gross Taxi Weight Per Gear, lbs
	1st	2nd	3rd	4th	Critic.	
B727-100	104.00	138.00	NA	NA	121.00	80,750.00
B737-300	95.40	125.90	NA	NA	110.65	66,500.00
B747-400ER	53.00	97.00	195.00	238.00	145.75	433,675.00
A320	131.16	167.66	NA	NA	149.41	71,628.10
A330-200	182.75	237.75	NA	NA	210.25	244,938.98
A380-800	73.50	133.70	218.65	271.75	174.40	588,525.00

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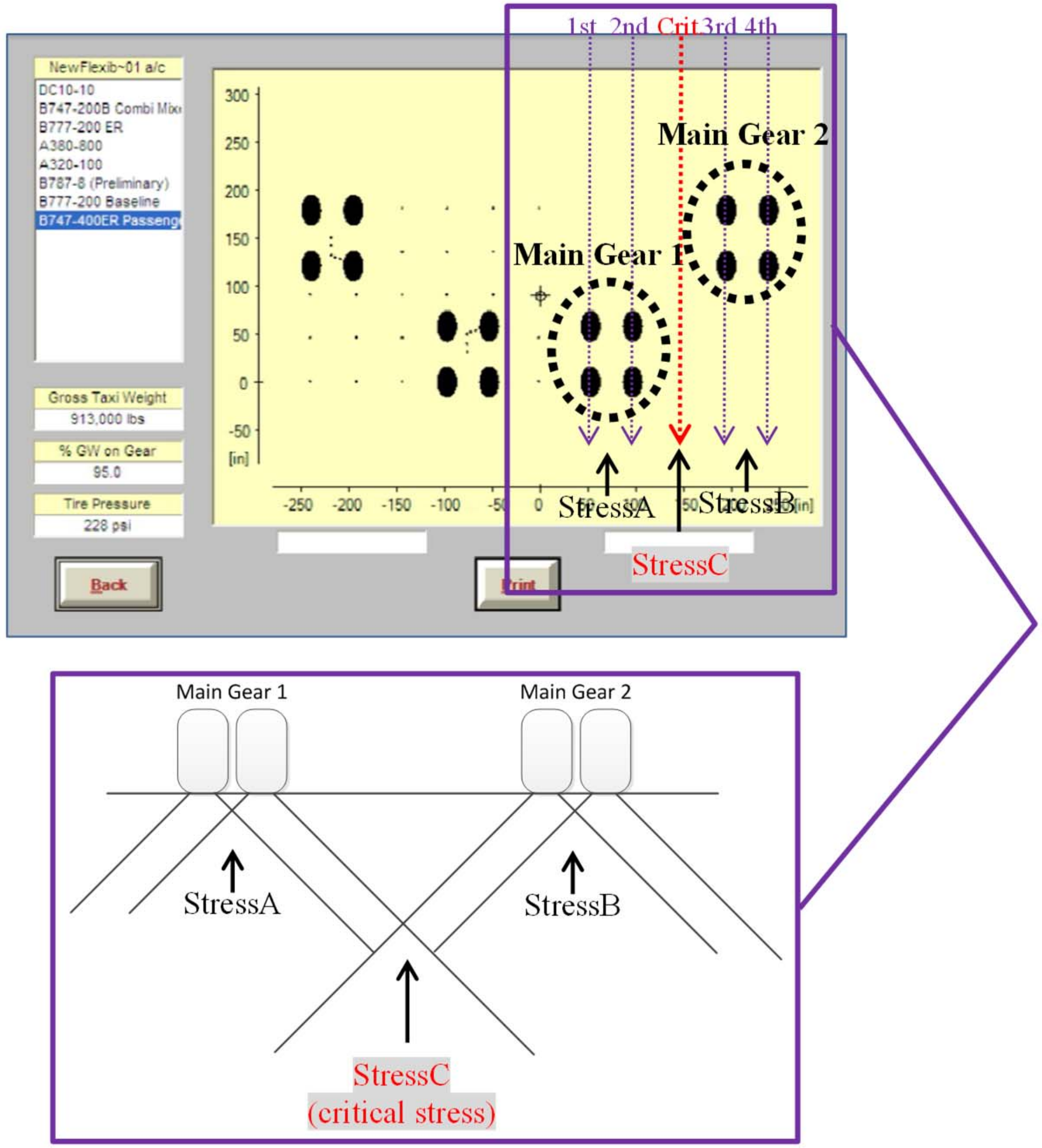
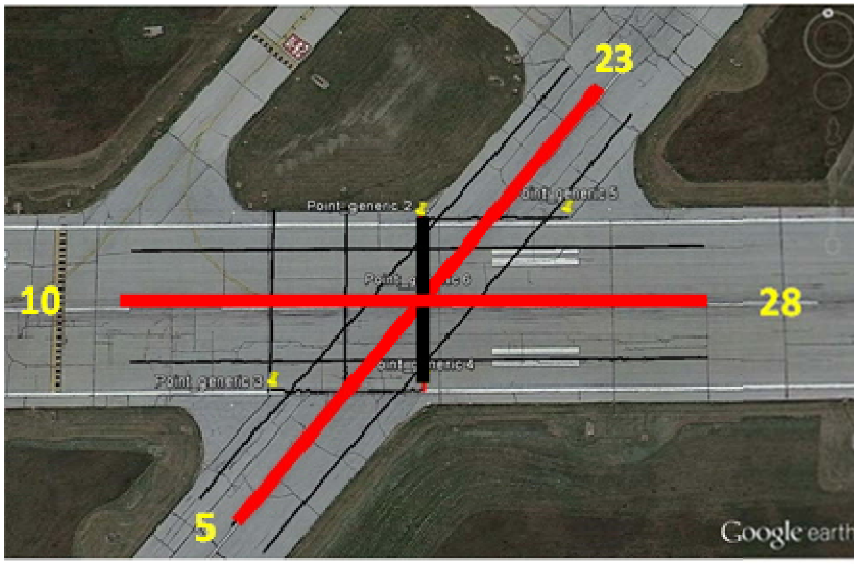
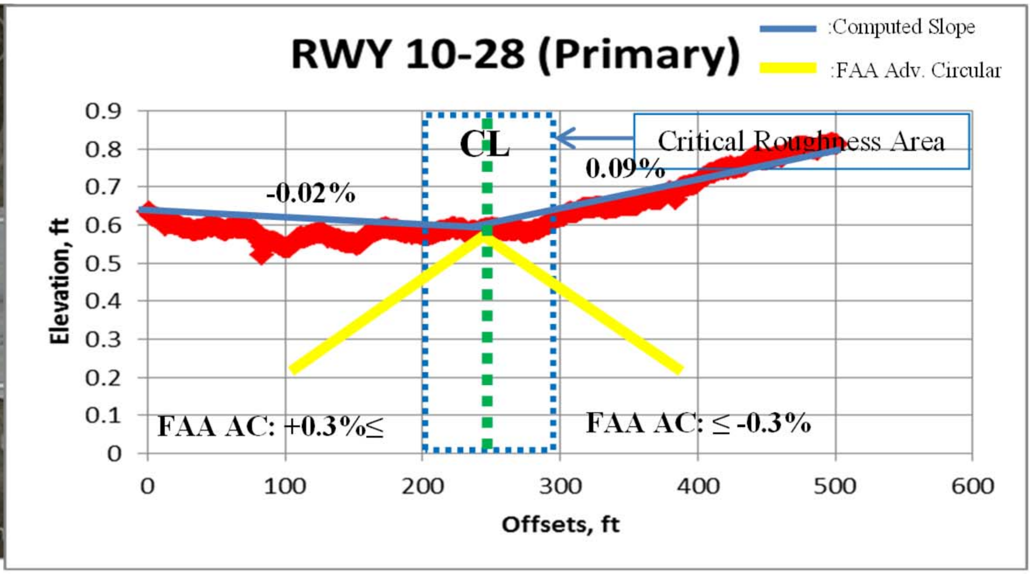
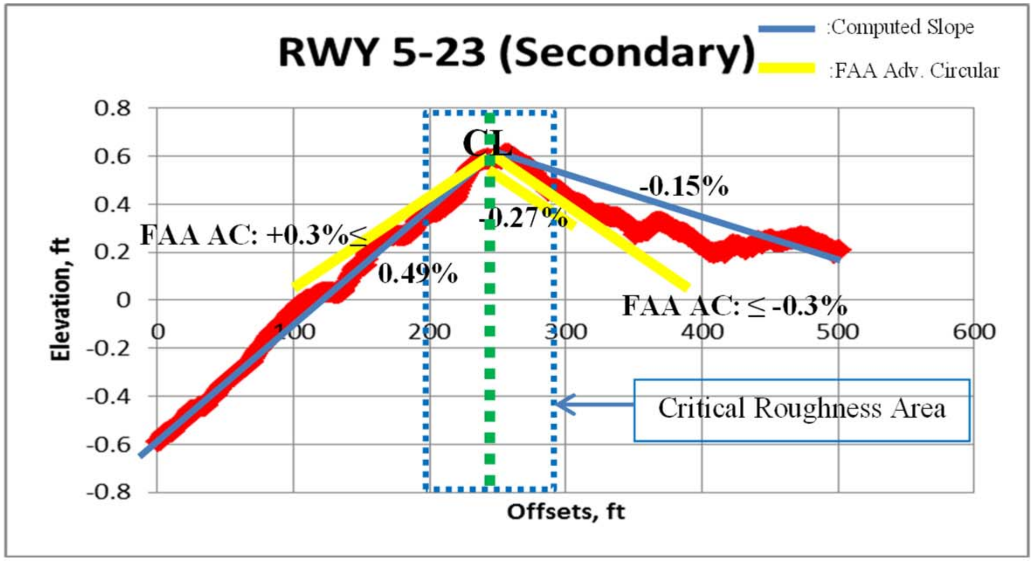
Critical Stress Area for Boeing 747



Airport A







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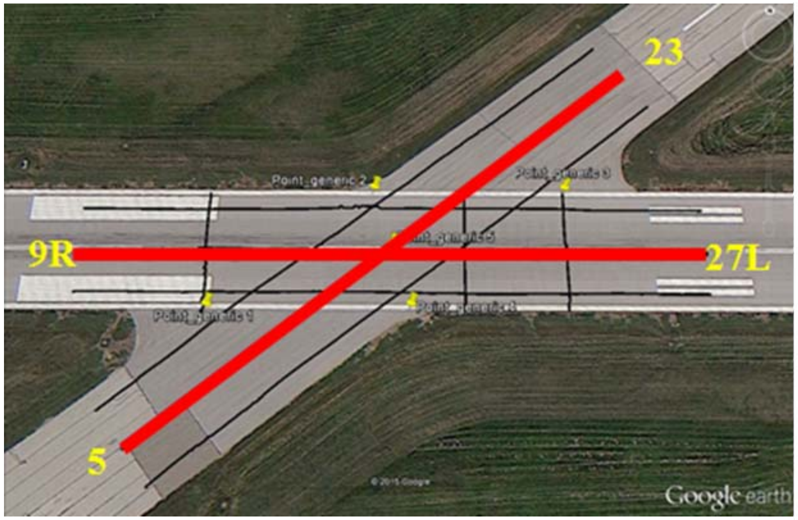
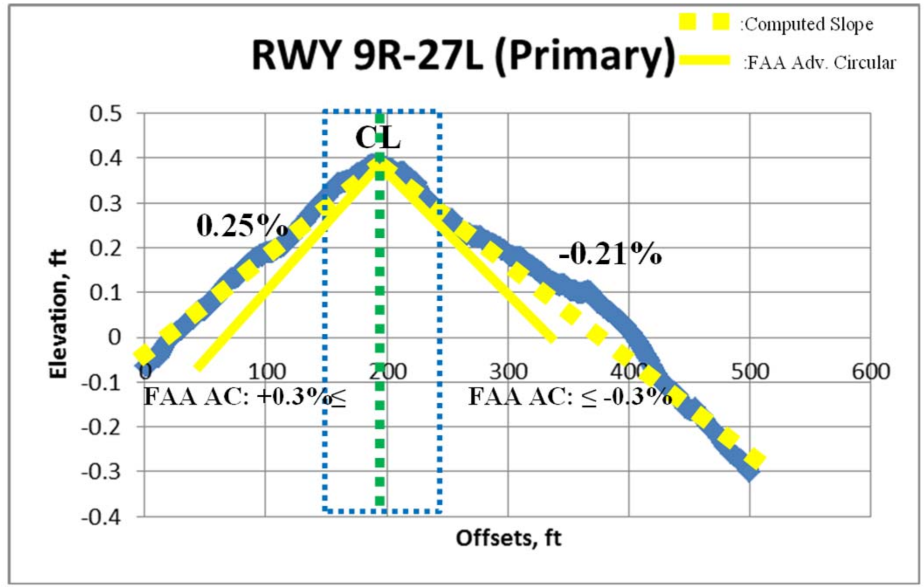
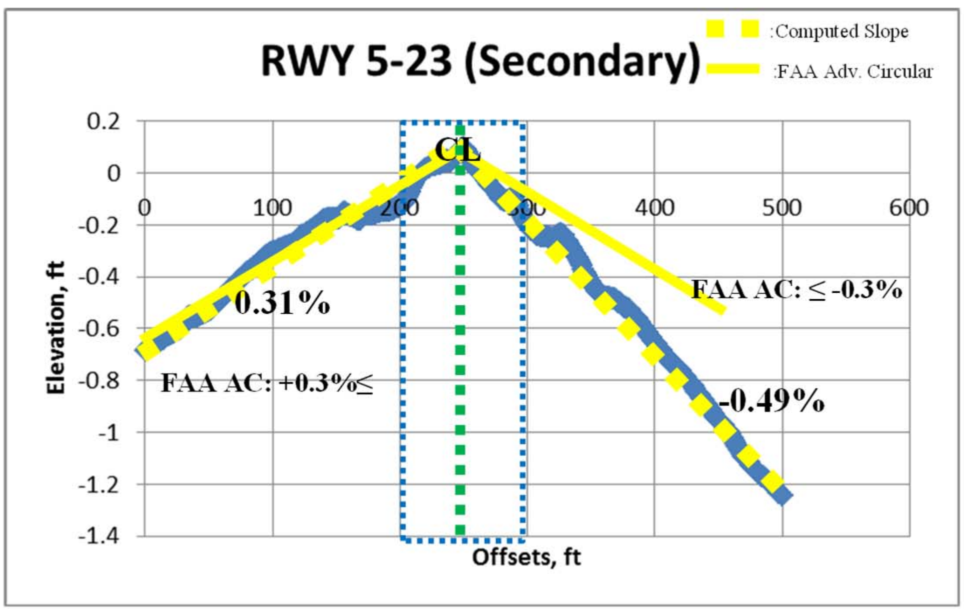
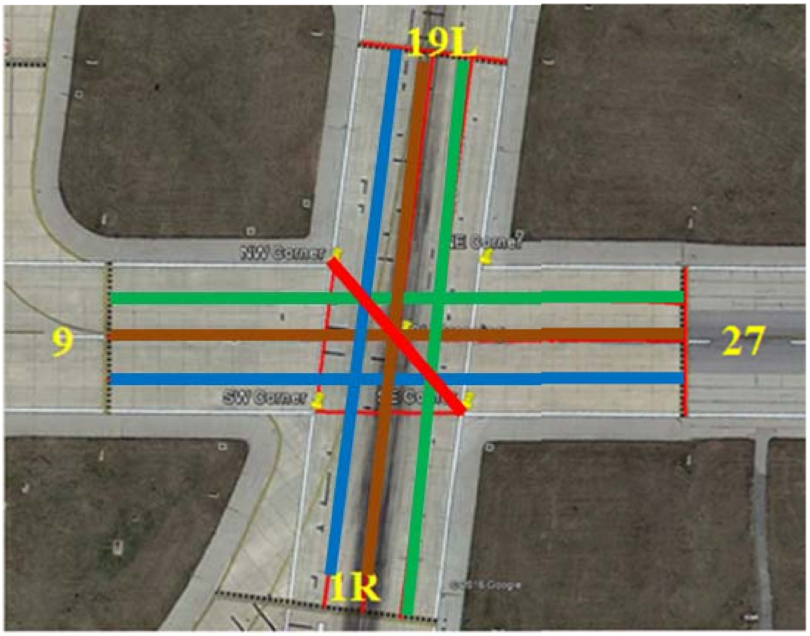
Airport B

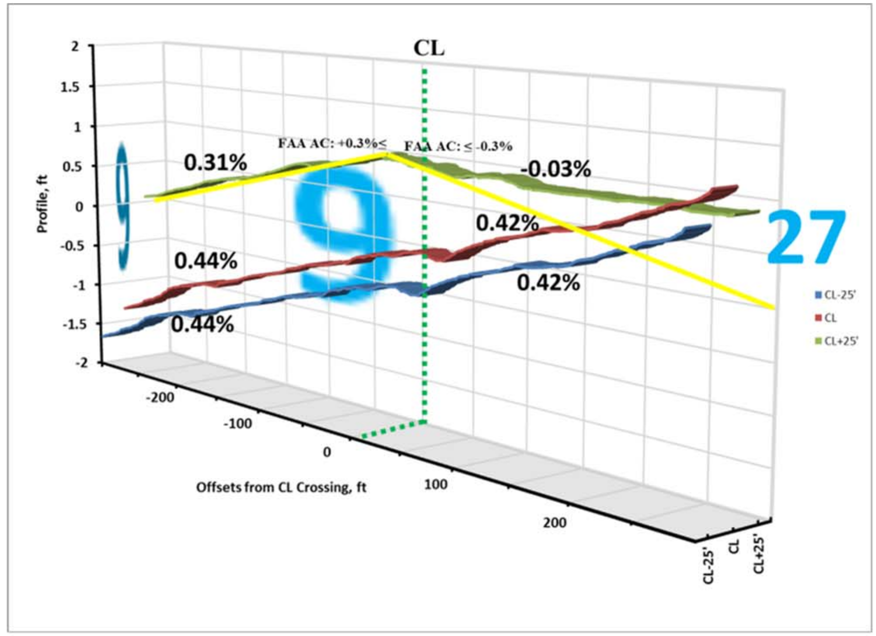

23
9R
27L
5
Google earth

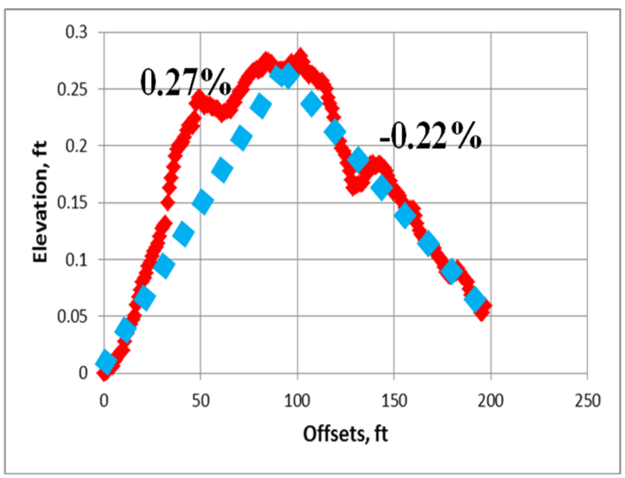

:Computed Slope
:FAA Adv. Circular
RWY 9R-27L (Primary)
CL
0.25%
-0.21%
FAA AC: +0.3%≤
FAA AC: ≤ -0.3%
Elevation, ft
Offsets, ft
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
0
100
200
300
400
500
600

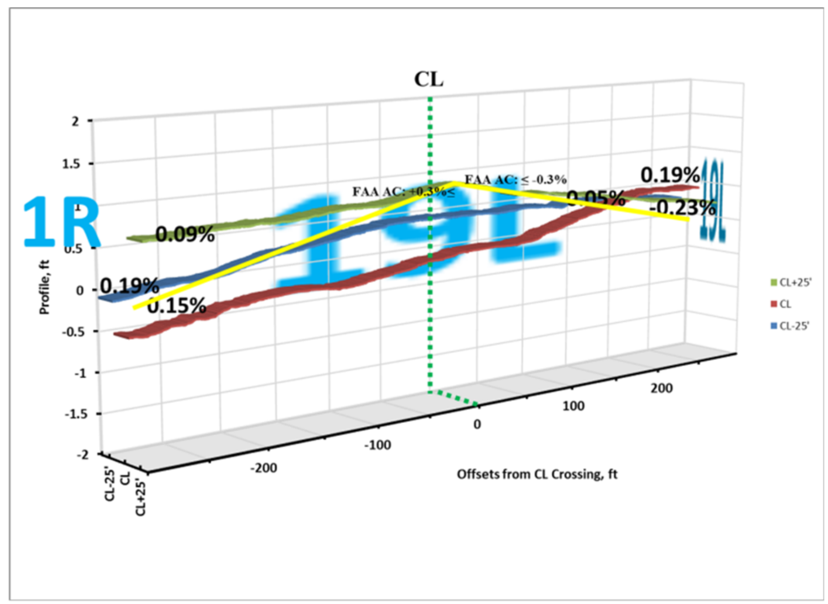

:Computed Slope
:FAA Adv. Circular
RWY 5-23 (Secondary)
CL
0.31%
-0.49%
FAA AC: +0.3%≤
FAA AC: ≤ -0.3%
Elevation, ft
Offsets, ft
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
0
100
200
400
500
600

Airport C









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Conclusions and Suggestions

- A methodology to measure profile data at runway intersection areas was proposed using an inclinometer type walking profiler at imaginary longitudinal and transverse profile lines.
- Considering the aircraft gear configurations acquired from the FAA pavement design software FAARFIELD, critical areas were defined in the actual profiles.
- It was observed that the profiles at pre-defined critical pavement area considering aircraft gear configurations show more deformation than the other area, as expected when this study has started.
- The direction of primary runway is treated as longitudinal in this study because current standards do not provide any clear descriptions on it. Therefore, it would also need to be clarified the profile types either longitudinal or transverse because the profile data is collected at runway intersection areas.

Conclusions and Suggestions (Cont'd)

- In continuations of this study, further investigations such as taking additional profile lines toward the shoulder of each runway in conjunction with the others including aircraft simulation projects would be suggested in the near future.
- Possible future research would need more efforts on characterizing the mechanical response of fuselages on pavement surface from various aircraft types including new large aircrafts.

Thanks

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