Aircraft Tire Water Spray Simulation using SPH

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Triangle Tire Co. Ltd.

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Content

- **Triangle** Tire Company
- Aircraft Tire water spray **test**
- Aircraft tire water spray **modeling**
- **Comparison** with experiments
- Conclusions

Triangle Tire Co. Ltd.: Weihai Shangdong

- Founded at 1976 ;
- Stock listed: 601163
- 2016 Sales: 6.8 billion RMB
- Products: PCR, TBR, OTR
- Technology: N. E. Lab. for Tire Design & Manufacturing Process
  National Industrial Design Center
  National enterprise technology Center
- Market: 60% export

Description of aircraft water spray test

The waterlogged runway

Spray water caused by tire will be injected into engine. The loss of en gine power will cause safety problem of taking-off and land operations


Before running in water spool


Running in water spool

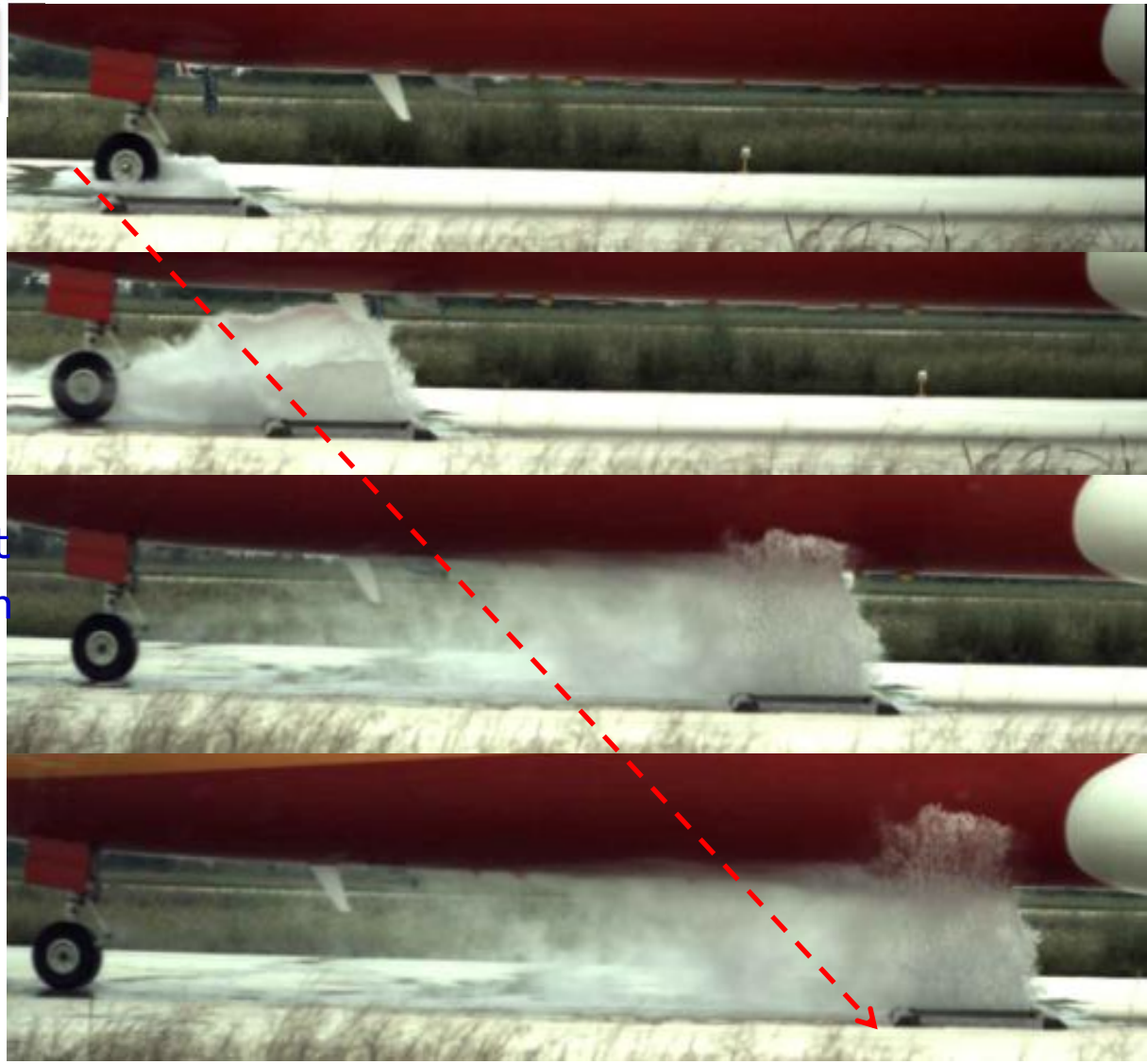

Running in water spool


Running out from water spool

Short water spool test

1m(length)*0.6m(width)
(short water spool size)

Short spool images illustrated the conclusion that water particles almost have the same track line in running direction.

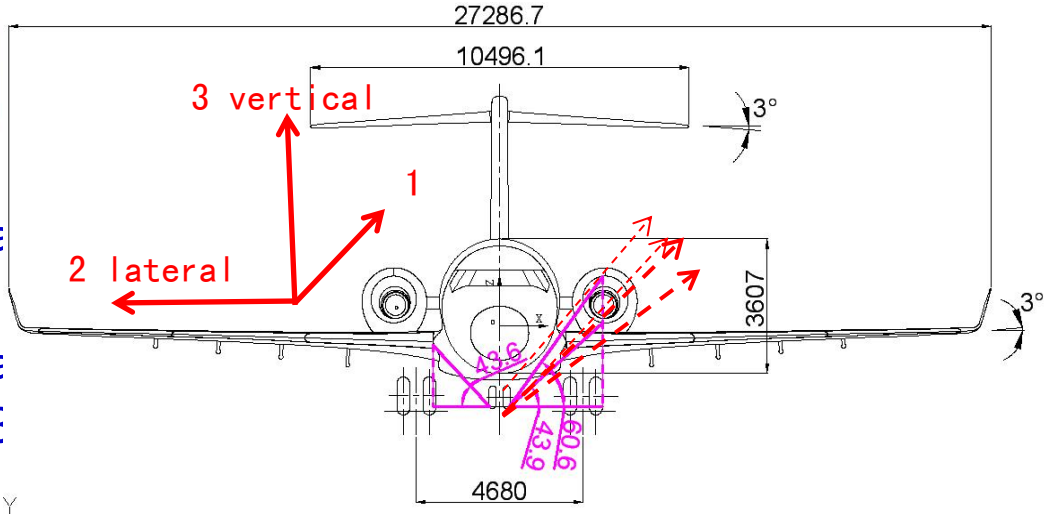


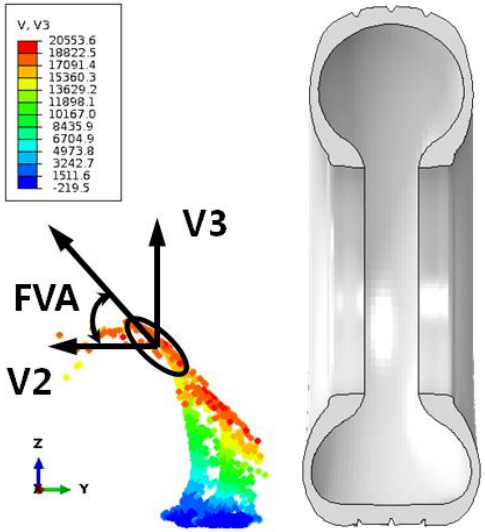
Water Spray Characteristics

the water spay characteristics ca
be defined by an angle and two
velocities. The two velocities a
the lateral (V2) and vertical (V3
speeds. The angle formed by
vertical speed V3 to the lateral
speed V2 is named as Frontview
angle (FVA)

Tan(FVA)=V3/V2

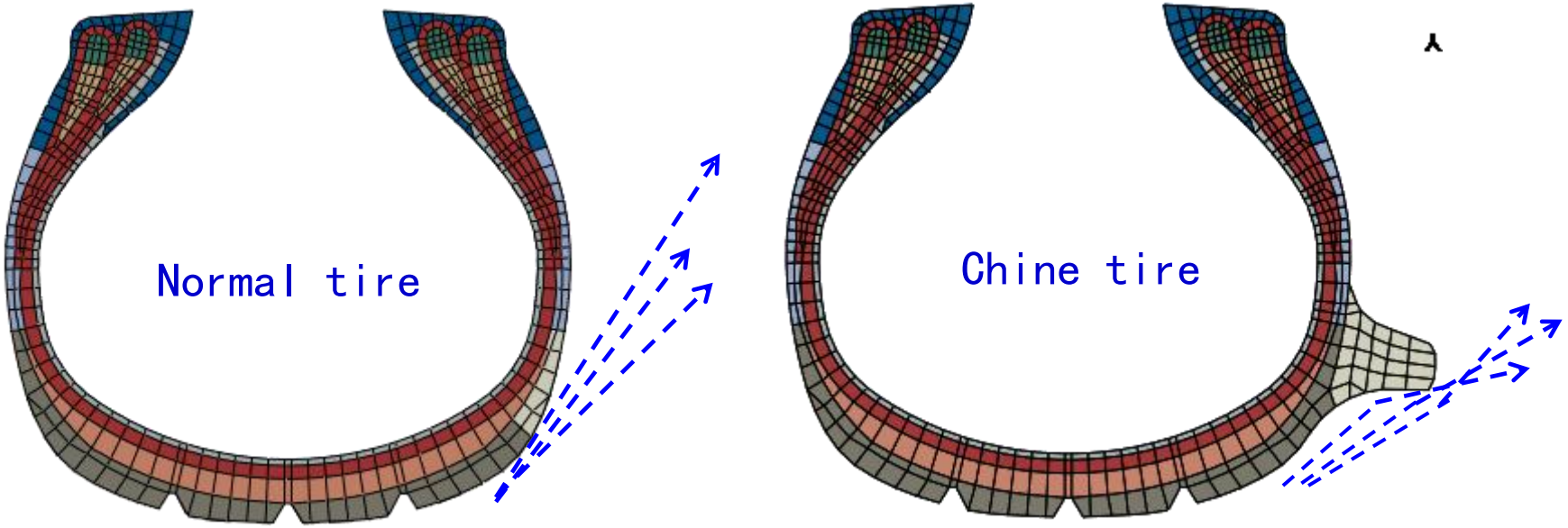
V3, vertical speeds
V2, lateral speeds





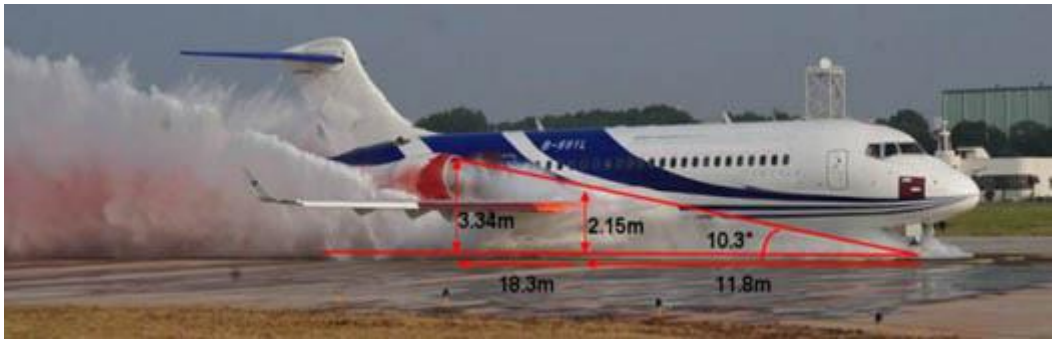
Value of tire water spray simulation

Predict water spray characteristics
Reduce largely testing cost
Optimize chine design
Research tire water spray theory

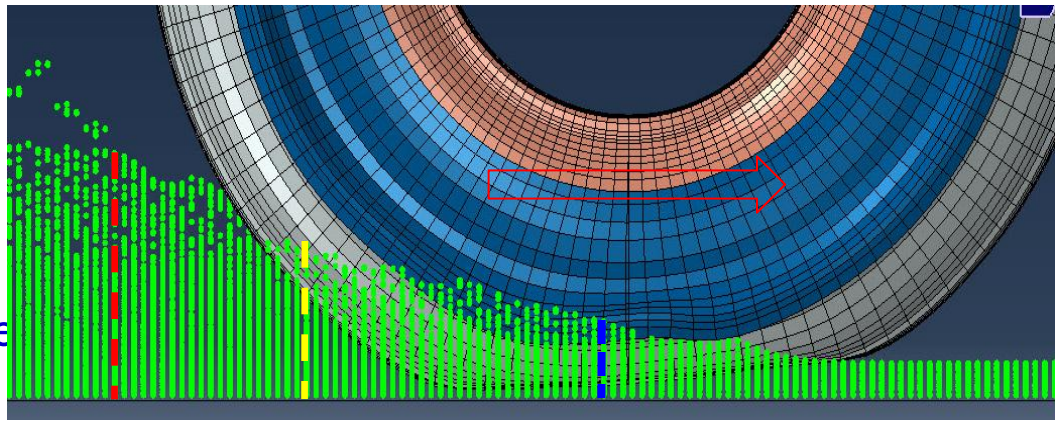


Water Spool size

12m*0.6m*0.016m
(testing water Spool)



Water particles almost have the same track line in tire running direction. In tire side direction, water particles away from tire footprint rarely affect track line of particles ne tire footprint

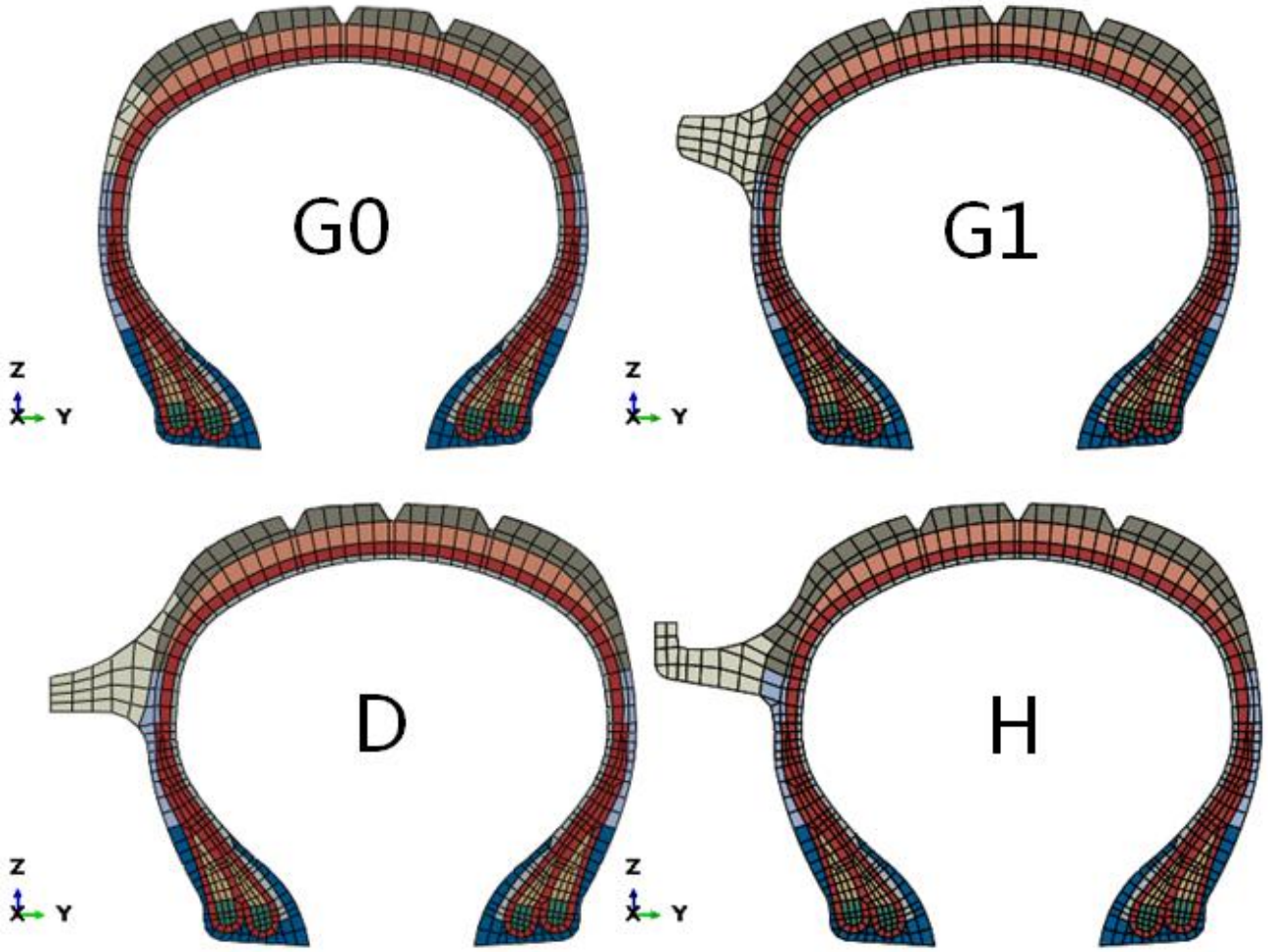


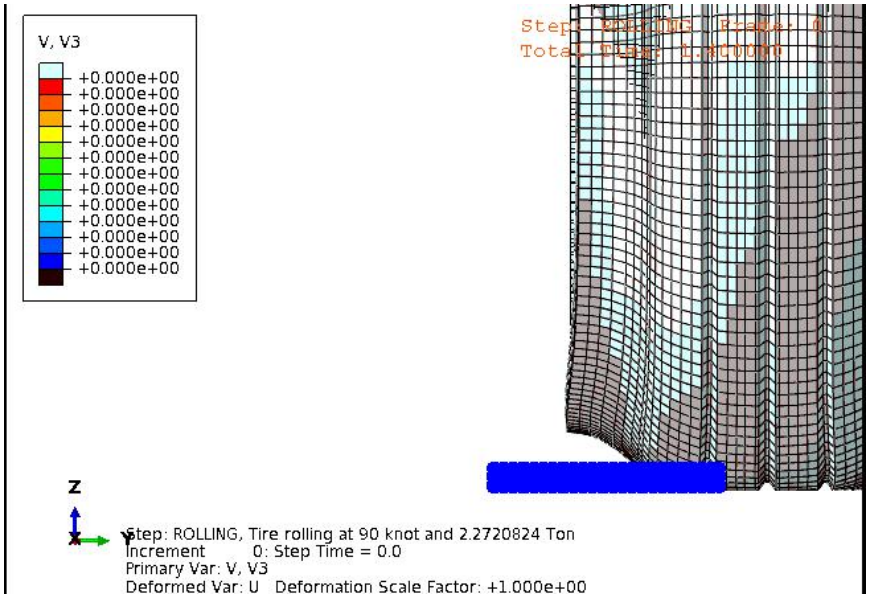
water spool size is reduced to
1200mm*300mm*16mm
(water spool model)

Chine design parameters

Shape

Material




V, V3
+0.000e+00
+0.000e+00
+0.000e+00
+0.000e+00
+0.000e+00
+0.000e+00
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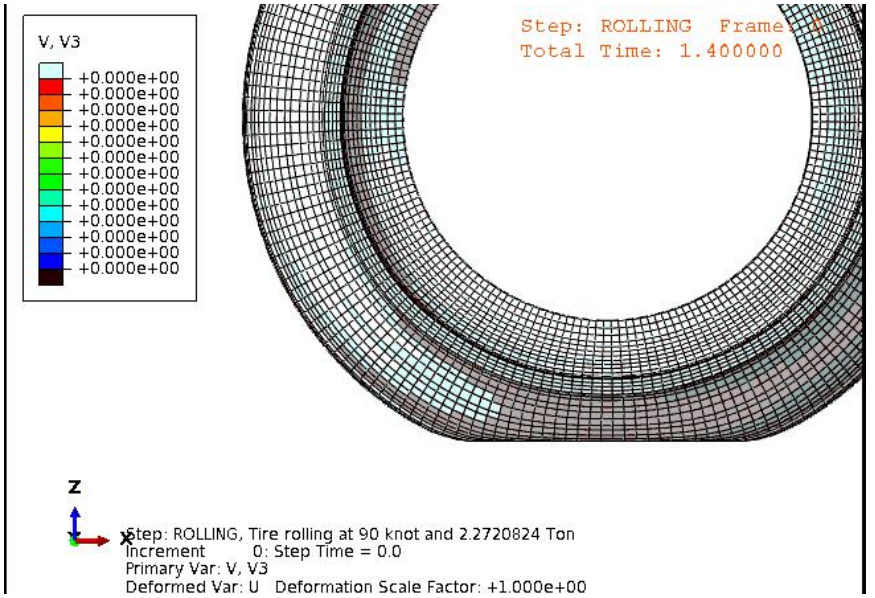
+0.000e+00
+0.000e+00
+0.000e+00
Step: ROLLING Frame: 0
Total Time: 1.400000
Z
Y
X
Step: ROLLING, Tire rolling at 90 knot and 2.2720824 Ton
Increment 0: Step Time = 0.0
Primary Var: V, V3
Deformed Var: U Deformation Scale Factor: +1.000e+00


V, V3
+0.000e+00
+0.000e+00
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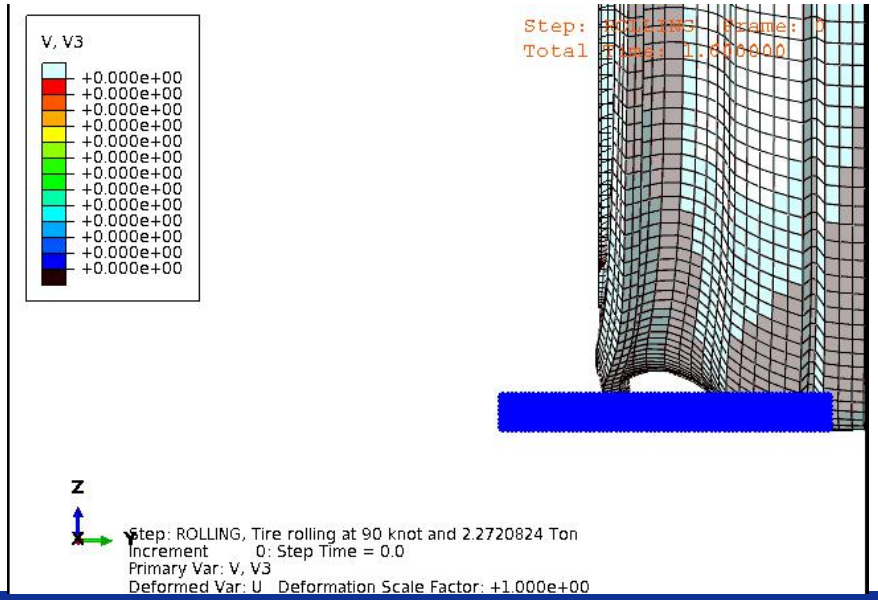
V, V3
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Step: ROLLING Frame: 0
Total Time: 1.600000
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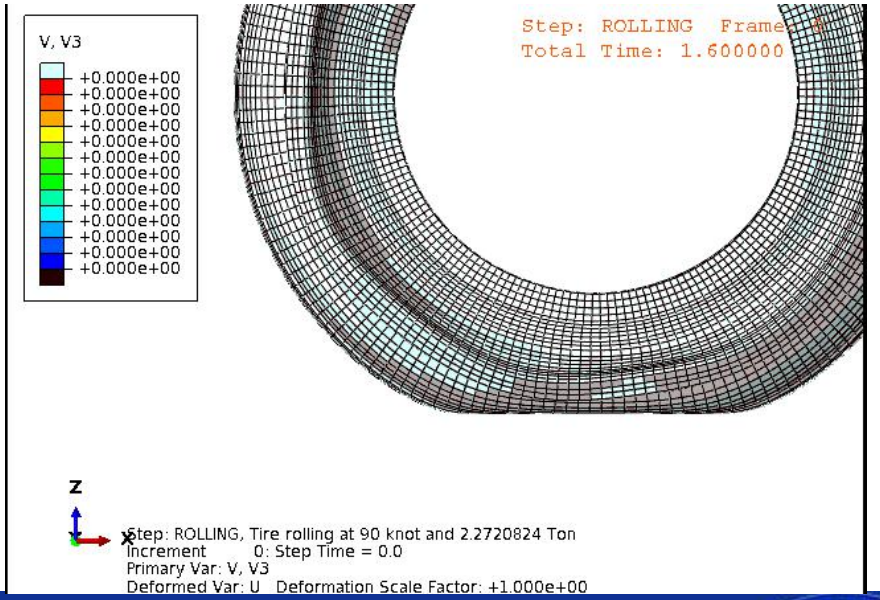
Y
X
Step: ROLLING, Tire rolling at 90 knot and 2.2720824 Ton
Increment 0: Step Time = 0.0
Primary Var: V, V3
Deformed Var: U Deformation Scale Factor: +1.000e+00


V, V3
+0.000e+00
+0.000e+00
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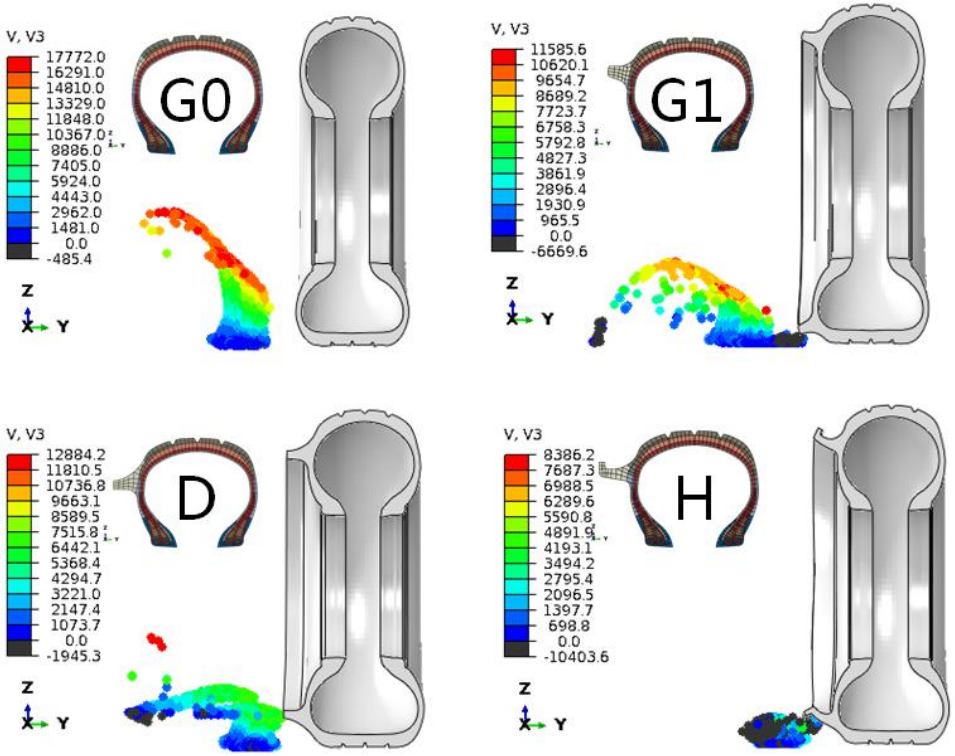
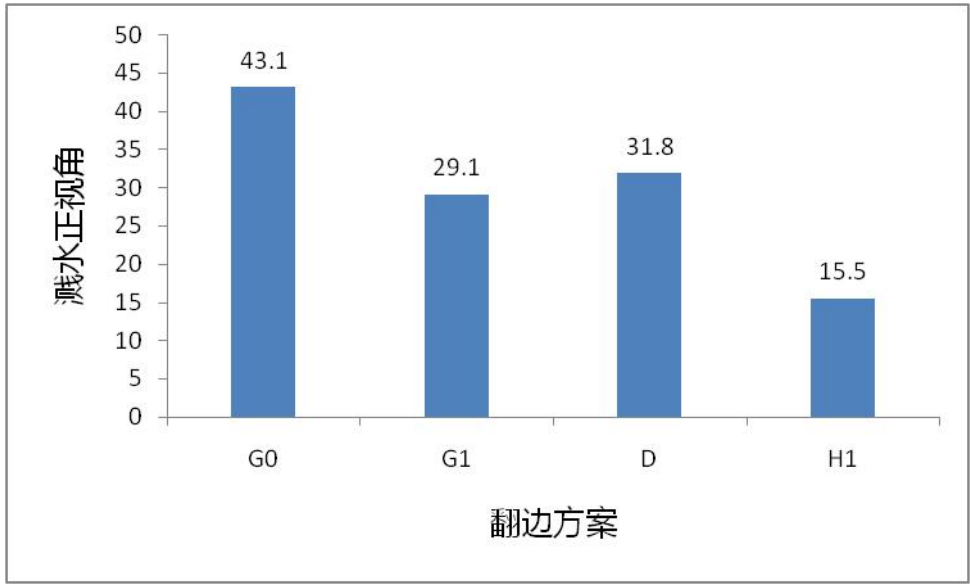
Prediction results:

Standard condition: 90Knots，100%Load

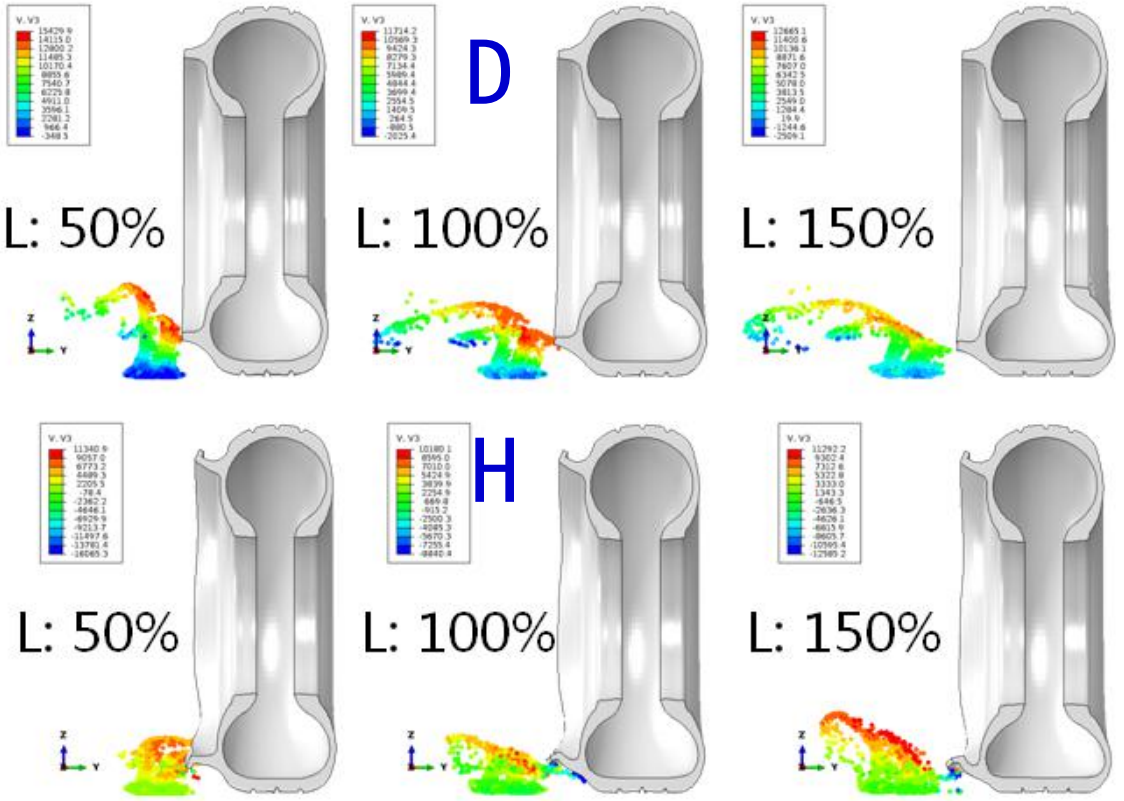




Impact of tire loads at high speed

Speed:110Knots
Loads : 50%, 100%, 150%

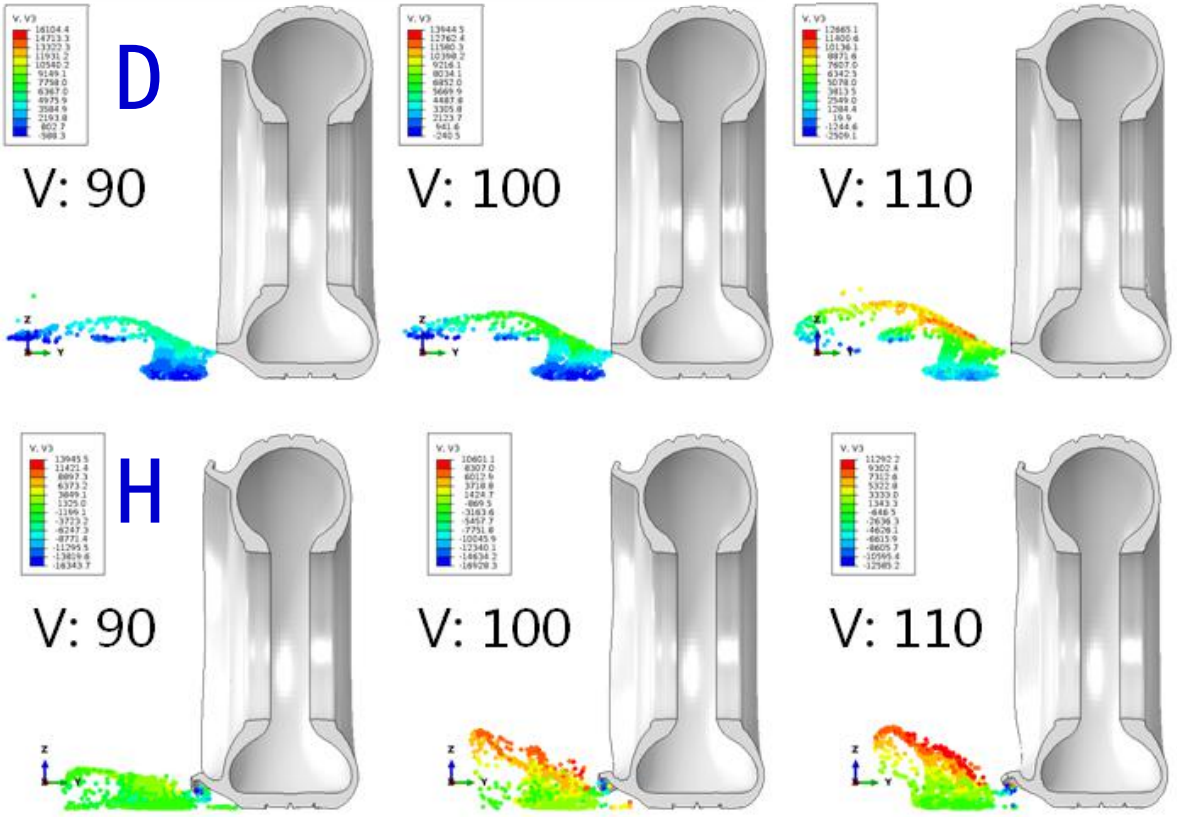
It shows tire load has different influence on the water spray. D design shows a decrease of the FVA with the increase of tire load whereas H design shows the opposite trend



The impact of Speeds on water spray at heavy tire load

Load: 150%
Speeds/konts:
90,100,110

Both D and H design show an increase of FVA With the increase of aircraft velocity, especially H design

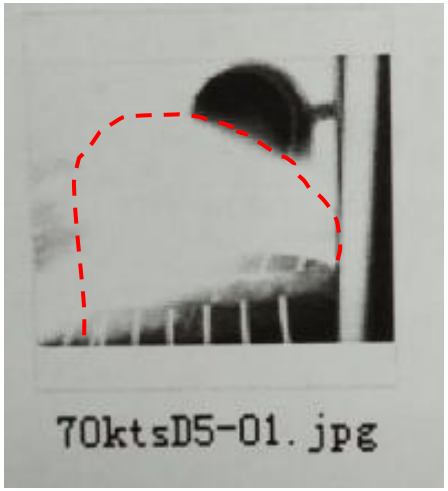


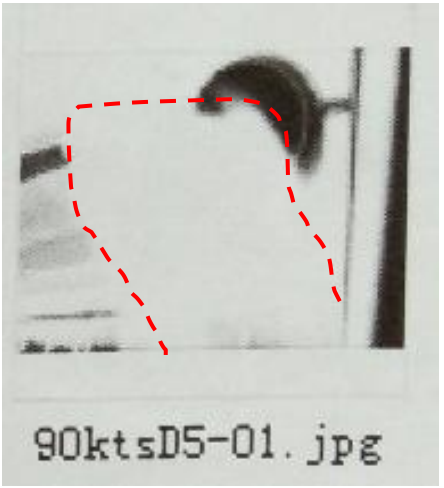
Aircraft water spray runway test

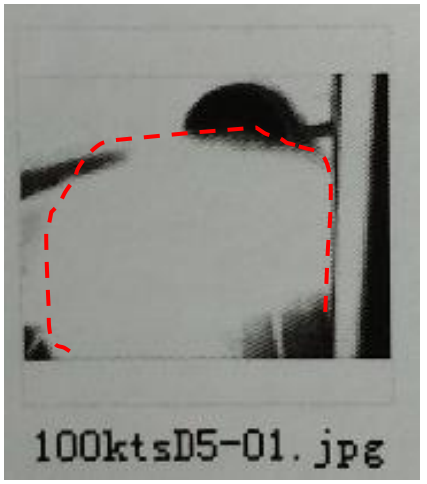
Nov. 2016, Yanliang ,Xi’an,

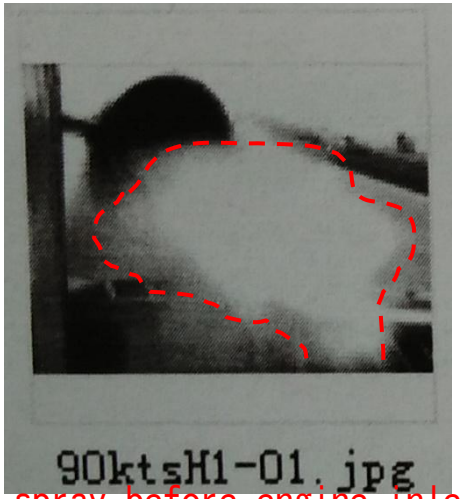
Testing images show that both D and H designs don’t completely prevent water injected into engine at all conditions.

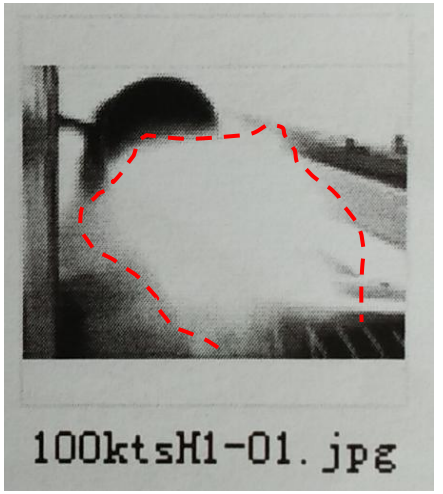
H design is better than D design











The red dotted line is the envelope line of water spray before engine inlet

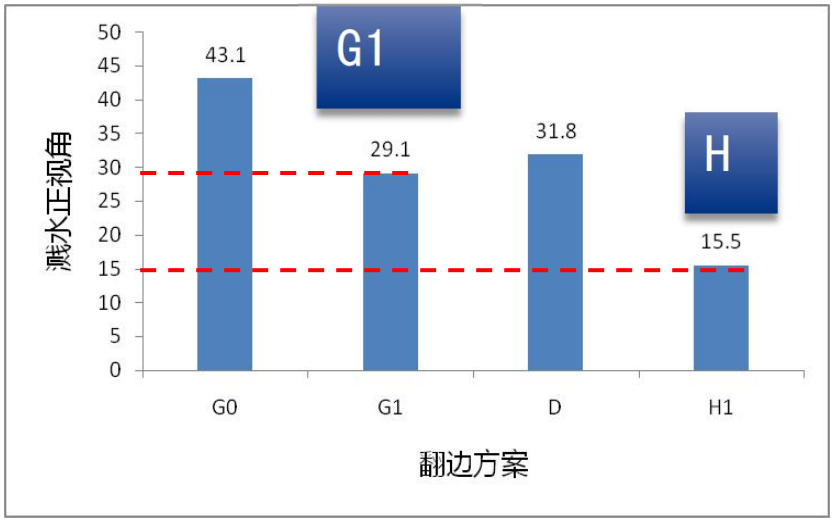
Speed/knots	Index of engine dropping speeds		
Design	H	D	GO
50	0.5	0	
70	0	1.5	
90	1	1	2
100	2	2.5	4
110	1	3	3
130	0.2	2.5	1.5

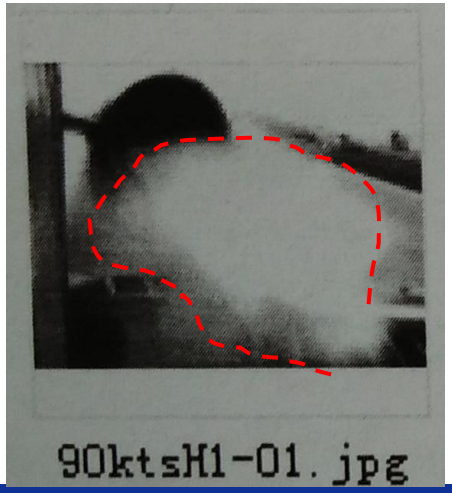
Engine data also show that H design is better than D design

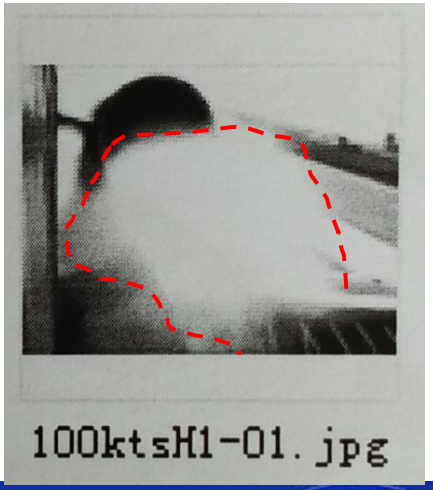
Next: your Helps and Ideas?

Prediction:

Real test: Why?







Thanks

SPH water particles information

Abaqus 6.14-5

Particle distance : 2mm*2mm*2mm, uniform distribution

EOS: Us-Up
1.500E+6,0,0

Contact form: general contact

friction: 0.01