Watertight simulation with SPH

Contents

I. Overview of Technology Development

❑ Purpose

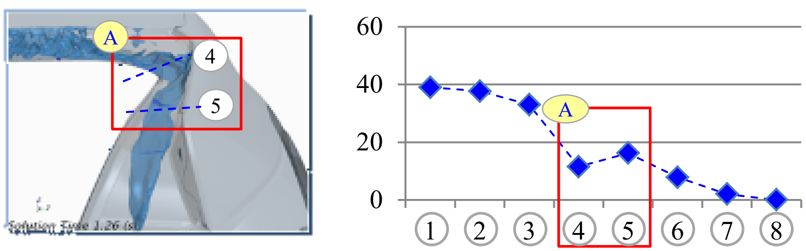
- To develop a visual prediction analysis technique for the path /drainage conditions of watertightness problems caused by manufacturing deviations.

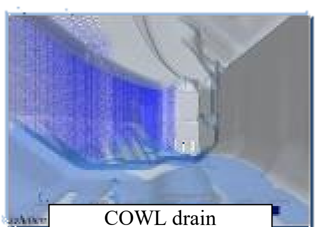
  └ (Interval/deformation between panels, sealer crack, W/STRIP mounting conditions, assembly dispersion, etc.)

❑ Content

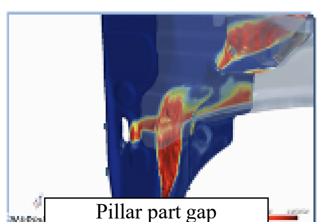
AS IS

□ Water tightness prediction analysis using FVM
→ Detailed analysis is possible, but it takes 5 months from modeling to analysis, so it is difficult to apply





COWL drain
Flow Path Analysis

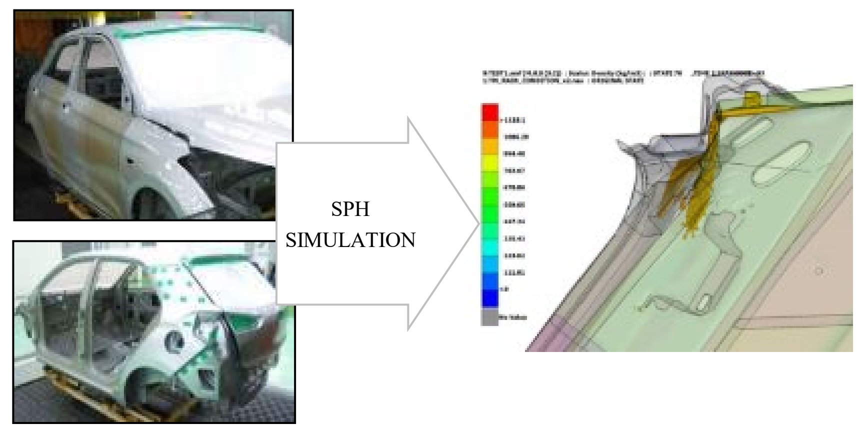


Pillar part gap
Leakage analysis

TO BE

□ Development of a Predictive Analysis Method for Watertightness Using SPH

1. Visual prediction of watertight robustness in the drawing stage (required time : within 2 weeks)
2. Securing watertight quality in the drawing stage through BIW watertight analysis



❑ Effects

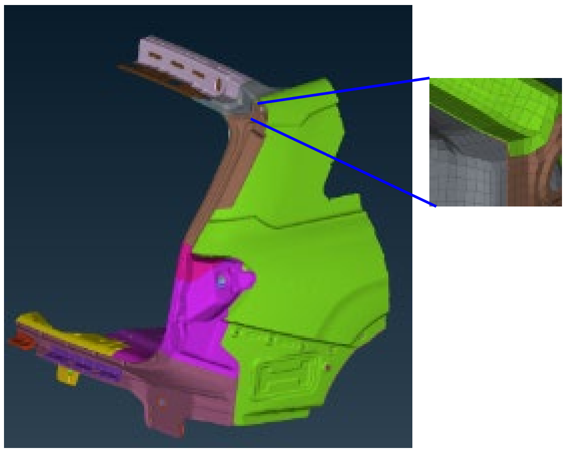
- To reduce the quality assurance period and prevent field claims through early improvement of actual car problems
- Interactive simulation of watertight path /drainage through particle behavior analysis

II. Development Process

1. Process

Modeling

▶ Mesh modeling



▶ Setting of INLET AREA

Compare with real model(made by 3D printing) and simulation result

(3D printing of transparent materials)

▶ 3D printing on top of RH quarter

<3D printing assembly on top of RH QTR>

▶ Fluid to make visible (water + paint)
Flow comparison verification

▶ Analysis result and 3D printing after comparative evaluation of watertight test results

Case Analysis of Watertightness Problems

(parameter optimization by Case)

▶ Analysis of 28 cases with watertightness problems

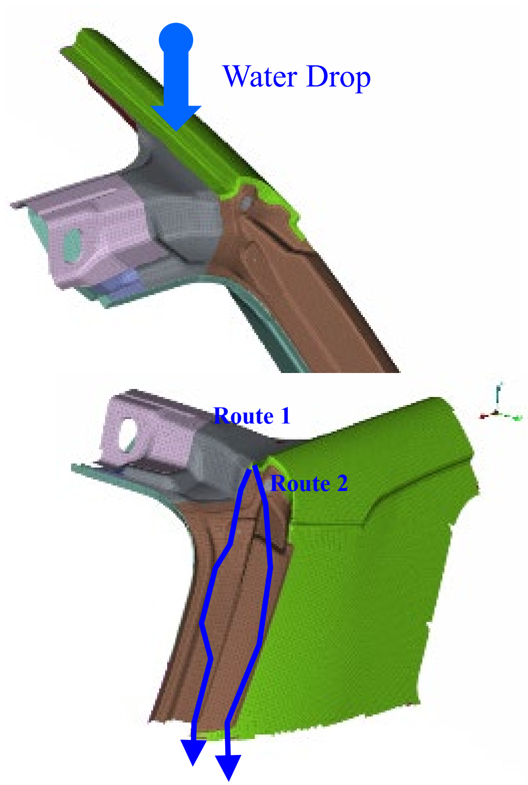
※ Parameters

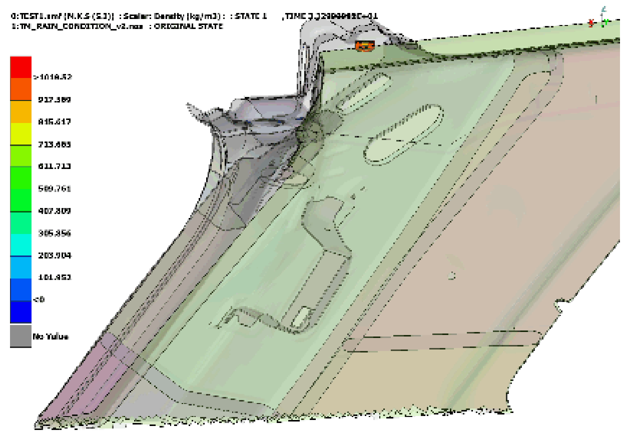
1) Speed
2) Particle size
3) Area of water inflow
4) Physical Properties
: Density, viscosity, surface tension , etc.

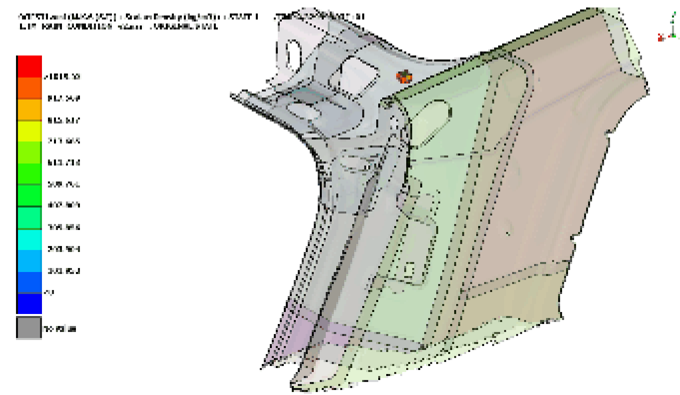
II. Development Process

2. Modeling and Solver Verification for Watertight Simulation

Modeling and Solver verificaion







▶ Simulation time : less than 1 day
(FVM reduced by more than 80% compared to 5 days)

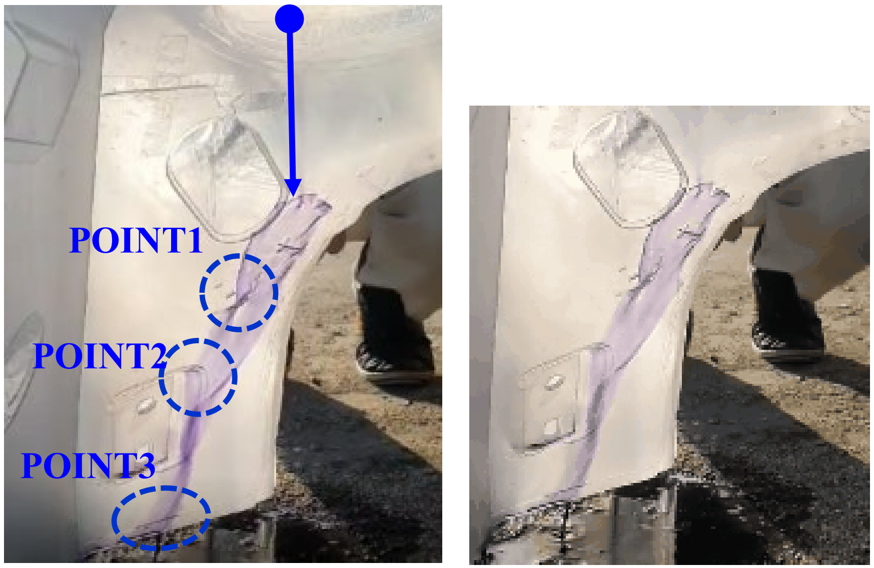
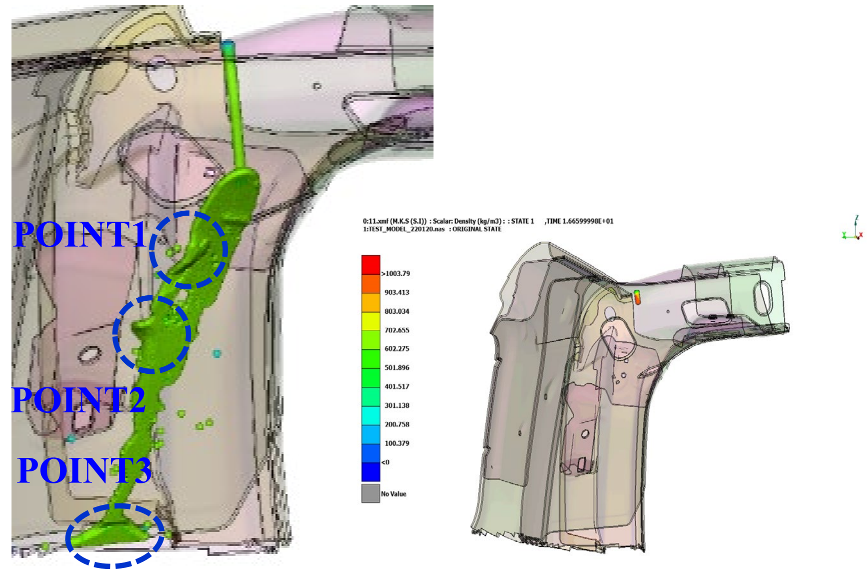
▶ result view angle can change
(For FVMs, different angle view Required simulation again)

1) Route 1 : path a waterway along the QTR side
2) Route 2 : path a waterway along the bend of REINF D PILLAR INR LWR after introducing a fine gap at the end of the roof

II. Development Process

3. Ensuring analysis consistency – 3 matching part at the top of quarter

- Using 3D printing of transparent materials

<table>
<tr><td rowspan="3">Results</td><td>Real Test Results</td><td>Simulation Results</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">1) Observation of bends affecting the water flow path confirms the same phenomenon between actual test and simulation results.
→ Check POINT1, 2, 3
2) Same path and spread of water
3) Same final location of drain</td></tr>
</table>

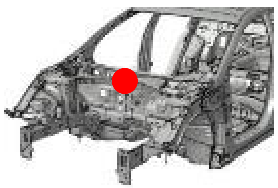
II. Development Process

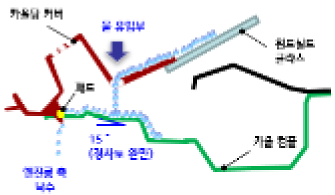
4. Simulation of Watertight issues

Subject to review: Verification of 28 major watertightness issues

▶ COWL
: Overflow of water and overflow to the engine room Occurrence

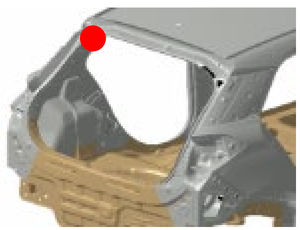
EX) COWL top cover & cowl panel matching slope OVERFLOW due to gentle movement





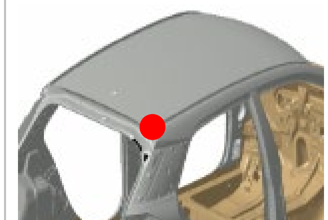
▶ W/STRIP
: Water tightness problem due to pressing amount, mounting defect, etc

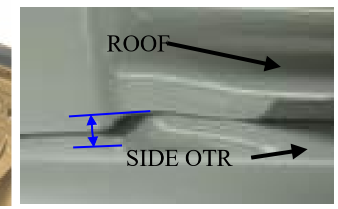
EX) Watertightness problem of T/G opening
: T/G opening body flange flush and welding
Defective W/STRIP installation due to bending



▶ BODY, CLOSURE PART, ROOF
: Water tightness problem due to body flush

EX) Watertightness problem at the end of the roof
: Height of flush for absorbing side outer panel and roof corrugation
Also, coating sealer coating defects due to excessive spacing



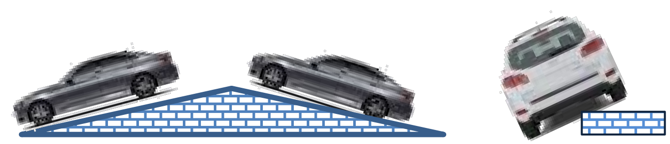


Analysis condition: change flow rate / inclination angle condition

▶ Analysis by flow rate condition

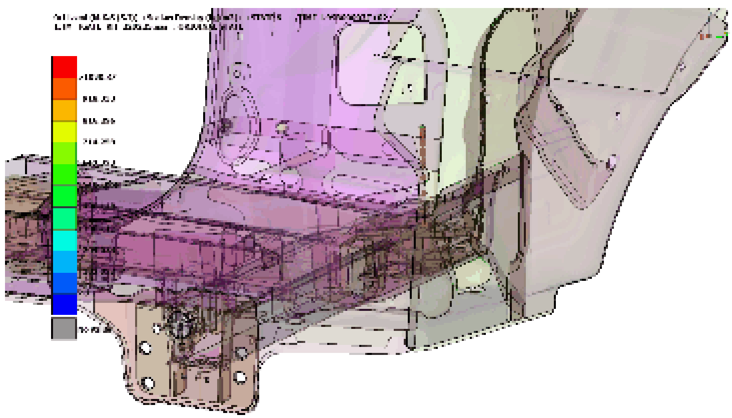
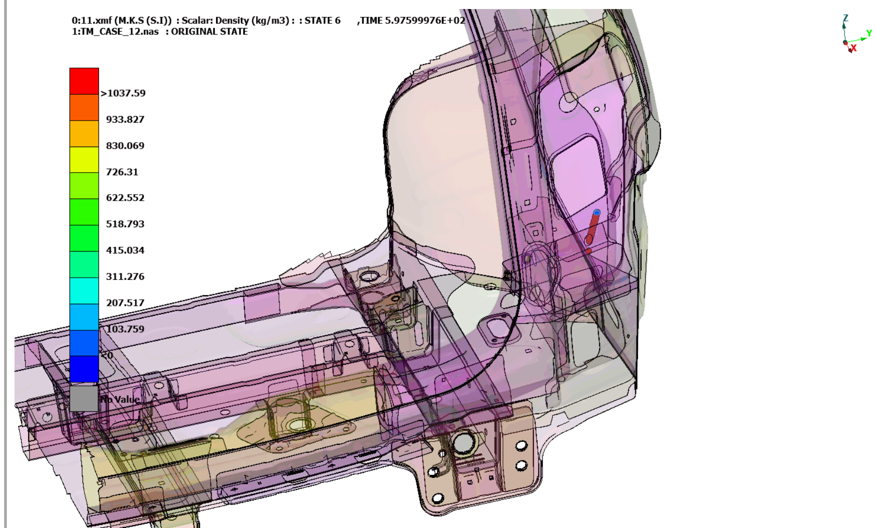
Classification	Flow velocity (m/s)
General conditions	0.04mm/s
Heavy rain conditions	0.1mm/s
High Pressure Wash Conditions	196000mm/s

▶ Analysis by slope condition (10~20°)
- Front slope
- Rear slope
- Frog parking slope



<Front slope> <Rear slope> <Side slope>

▣ CASE Analysis of Watertightness Problems_RR FLR Part of Slope Condition

	Flat (**0**°)	Left slope (20°)
Results		

	Angle	Flat	Left slope
Results analysis	Watertightness	Insufficient forming of RR FLOOR drainage induction	
	Internal inflow	O	O
	Water residue	X	O
	Path	Water is introduced at the right end of the body through the EXTN RR FLOR SIDE and drained through fine gaps.	EXTN RR FLOR SIDE → PNL RR FLOOR RR Stack after water is introduced

III. Conclusions and Future Plans

1. Conclusion

- Establishment of watertight path prediction analysis method using sph
  - Reduced analysis time compared to FVM: 80% or more (5 days of FVM → 1 day of SPH)
  - View angle can be changed (resimulation is required for FVM)
  - Use 3D printing to verify actual and simulation comparison

- Establish the suitable parameters from 28 cases
  - Analysis of cowl, w/s mounting, body, closure part, etc.
  - Analysis according to slope condition and flow rate change

2. Future Plan

- finding a suitable parameter(updated version added parameters)
- auto modeling using catia file
- delete a watertightness real car test (protoless)

▣ HOW TO CONTACT TO ME

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