1

INMM 30th Spent Fuel Workshop

Hitachi Zosen's current development with respect to SCC resistant canister, and a new shock absorber material

January 14, 2015

Ryoji Asano, Marina Morita
Hitachi Zosen Corporation

Hitz
Hitachi Zosen

2

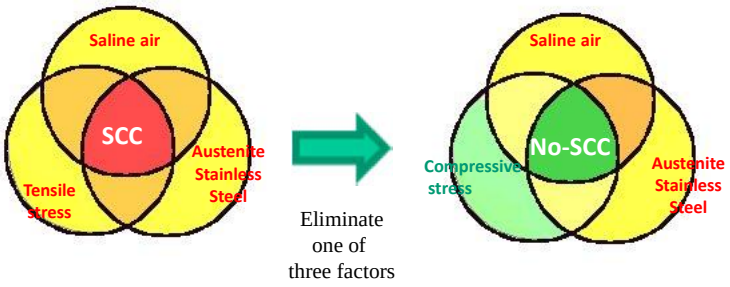
1. SCC Resistant Canister

Hitz
Hitachi Zosen

3

1. SCC Resistant Canister

To make a canister surface residual stress **compressive**, as a **preventive maintenance against** SCC



itz
Hitachi Zosen

4

I. SCC Resistant Canister

Specifications for SCC resistant canister

- **Material**
  Austenite stainless steel, Type 304L or 316L

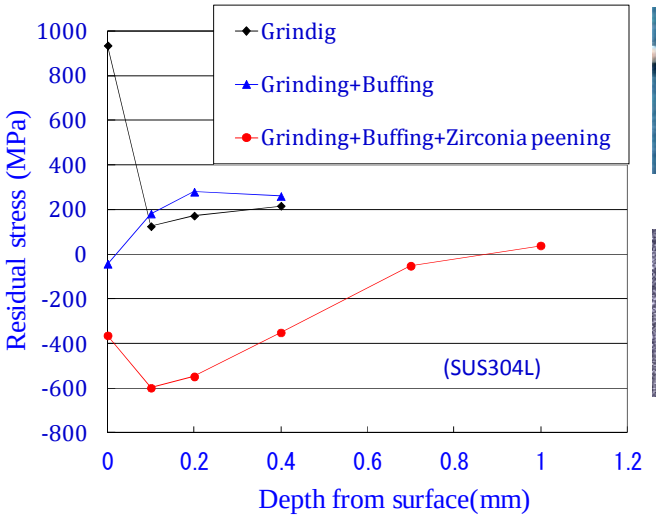
- **Surface processing methods (objective to make surface stress compressive)**
  (1) Completion of fabrication at factory:
  Zirconia Peening on whole surface
  (2) After lid welding at NPS:
  Burnishing on Weld and Heat Affected Zone (HAZ)

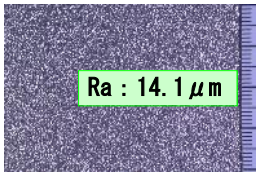
Hitz
Hitachi Zosen

5

I. SCC Resistant Canister

Measurement of residual stress in the weld (Zr peening)





Hitz
Hitachi Zosen

6

I. SCC Resistant Canister

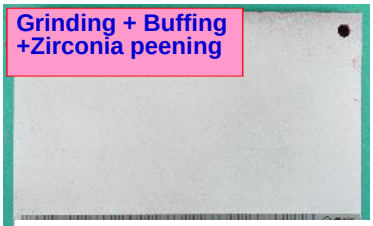
Stress corrosion cracking test in 42% $MgCl_2$ aqueous solution at 143

(JIS G0576):SUS304L

Cracks perpendicular to the weld line.

Cracks caused by grinding

Cracks are reduced by buffing



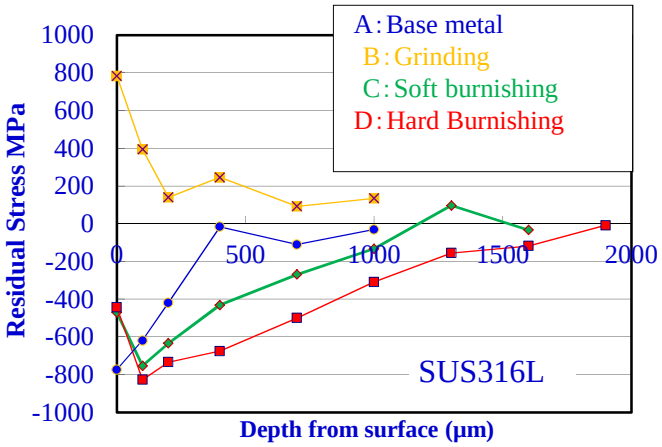
Crack is not observed

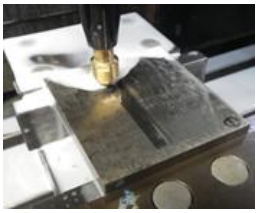
Hitz
Hitachi Zosen

7

I. SCC Resistant

Measurement of residual stress in the weld (ball burnishing)





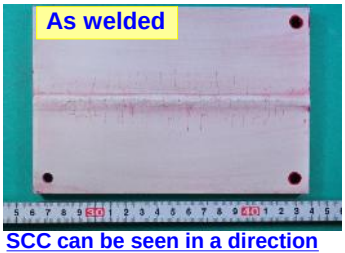
Ball burnishing

Hitz
Hitachi Zosen

8

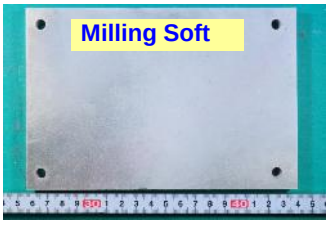
I. SCC Resistant Canister

Stress corrosion cracking test in 42% $MgCl_2$ aqueous solution at 143 (JIS G0576):SUS316L



SCC can be seen in a direction perpendicular to the weld line

SCC is not observed

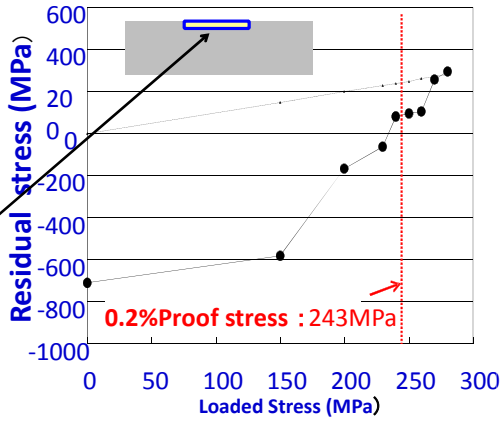


Milling surface has tensile residual stress, but the SCC instruction pattern is not confirmed

Hitz
Hitachi Zosen

I. SCC Resistant Canister

Stress change of the compressed area under tensile load



Design stress<<**0.2%Proof stress**

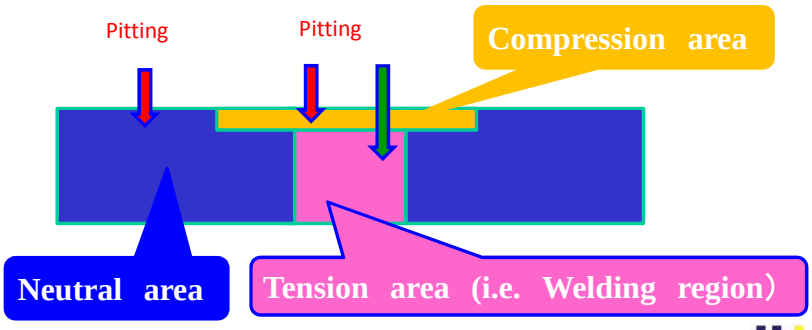
Hitz
Hitachi Zosen

I. SCC Resistant Canister

Pitting corrosion test

For long-term use, the SCC generation from the site of tensile layer beneath the compression layer by pitting is a potential concern.

(Material : 304L,316L)



Hitz
Hitachi Zosen

11

2. Shock Absorber Material: R-PUF – Rigid Polyurethane Foam

Hitz
Hitachi Zosen

12

2. Shock Absorbing Material: R-PUF

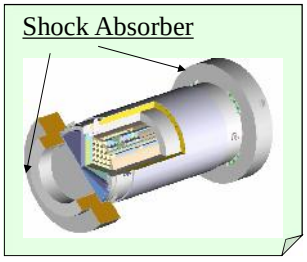
Background

Wood has been mainly used as shock absorber material because it has enough absortion capability with limited size.

It has become difficult to reliably procure wood that satisfies the characteristics specified by design.

R-PUF was chosen as shock absorbing material for two reasons

- Crush strength characteristic is adjustable
- R-PUF can be prepared at low cost comparable to the cost of the lowest-priced wood.



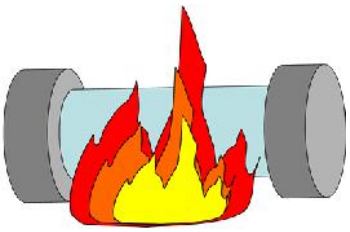
Hitz
Hitachi Zosen

2. Shock Absorber Material: R-PUF

Function of impact limiters

- To absorb impact energy at drop accidents

- To provide some insulation during fire accident

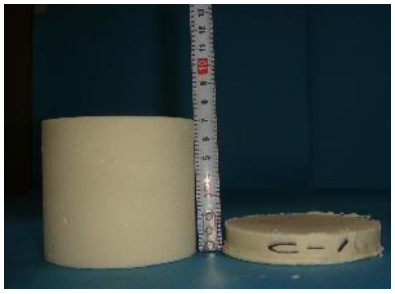


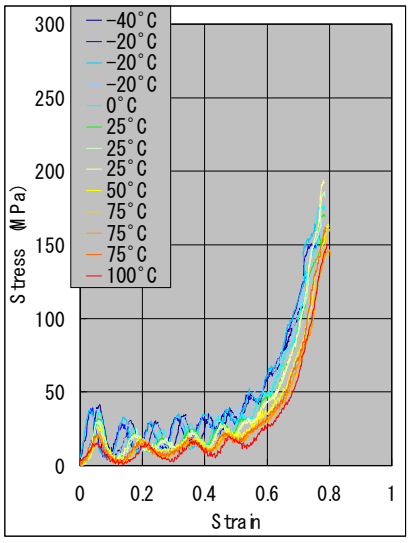
Hitz
Hitachi Zosen

2. Shock Absorber Material: R-PUF

Drop weight test

Crushing stress-strain curves for different densities and temperature conditions were obtained.



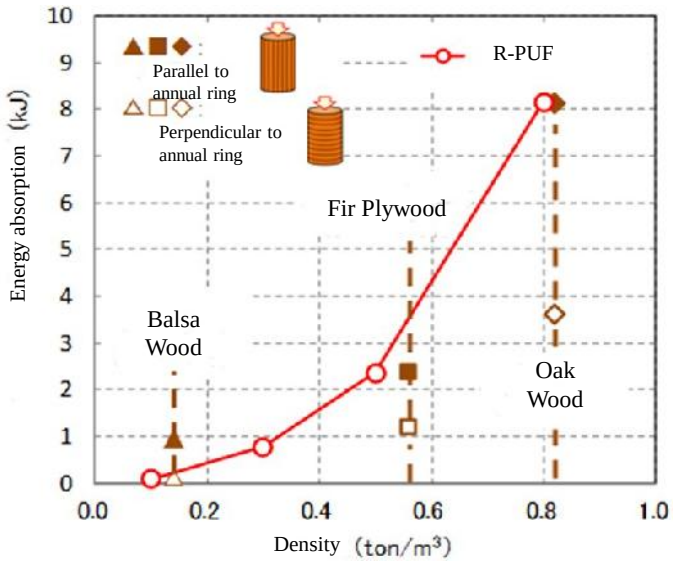


Hitz
Hitachi Zosen

15

2. Shock Absorber Material: R-PUF

Comparison with woods (Image)



Hitz
Hitachi Zosen

16

2. Shock Absorber Material: R-PUF

Self-extinguishing – Limits heat source in fire envent

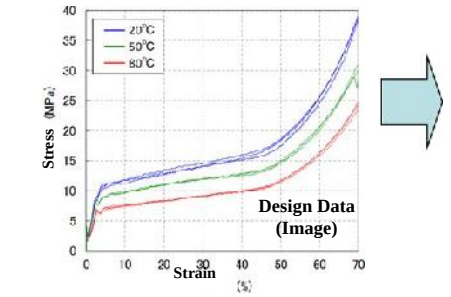
Just after 30 minutes 800◦C fire test

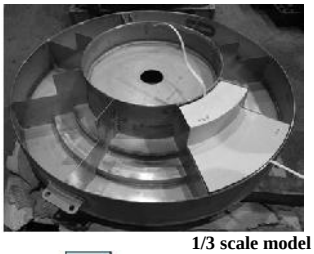
Flame extinguished after 10 minutes.

Hitz
Hitachi Zosen

17

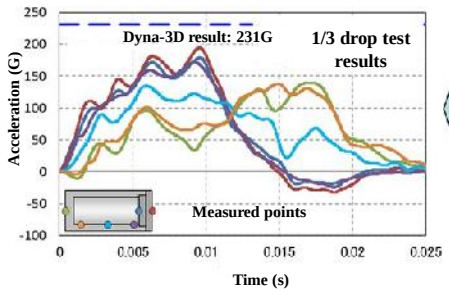
2. Shock Absorber Material: R-PUF





1/3 scale model

Drop test



Hitz
Hitachi Zosen

18

Conclusions

1. SCC Resistant Canister

- Both Zr peening and ball burnishing are effective methods to make canister surface stresses compressive.
- SCC is not induced provided that the surface stress is compressive.

2. Shock Absorbing Material: R-PUF

- Stress strain curves of R-PUF under each temperature condition were obtained by drop weight test.
- The 1/3 scale model drop test shows that the impact limiter composed of R-PUF has superior shock absorbing performance.
- Ability to customize shock absorbing properties
- Excellent self-extinguishing performance.

Hitz
Hitachi Zosen