High-speed solid-state joining of aluminum alloy stud on aluminum-resin composite panel

**Background**

Metal-resin composite panel
- Lightweight
- Good appearance, rigidity, smoothness
- Various properties by combinations of skin and core material

Currently, for the installation mechanical method is used ... Ordinary welding method degrades the panel by its large amount of heat input

Applying High-speed solid-state joining method for the installation to achieve metallurgical bonding

**Objective of the present study**

**Experimental**

High-speed solid-state stud joining
- High-density discharge current runs though the contact point of the stud and the panel.
  - Short welding time
  - Low amount of heat input
  - Deformation or melting of the panel can be suppressed

- Materials
  - A2024-T3 stud
  - 4mm thick composite panel
    Skin = 0.5mm A3105-H14
    Core = 3mm polyethylene resin
  - Discharge voltage: 270 - 300V (4 cond.)
  - Applied pressure: 0.2MPa

The welding machine was developed by Akebono Kikai Ltd.

**Results**

**Observation of the joined area**

- Joining was obtained only on the outer side of the stud projection.
- Deformation of the crystal grain of the stud
- Joined area
- Thinning of the skin plate of the panel... increased with higher discharge voltage. = larger amount of heat input

**Tensile test / Interruption test**

- With higher discharge voltage,
  - decohesion between the skin plate and the core resin of the composite panel was observed beneath the stud projection after the test
  - 1st stage peak appeared on the load-stroke curve after the elastic region.

- After the interruption test at the 1st stage peak...
  - Decohesion occurred
  - No fracture of the joint

The joining of the stud and the panel is stronger than the composition panel structure after the joining

**Decohesion of the composite panel**

- Decohesion of the skin plate and core resin outside the projection tip was observed after the joining process. This decohesion did not occur if only air pressure was applied (i.e. no discharge current was introduced)
- Softening of the skin plate (occurred by Joule heat) observed not only on the plate surface.
- When the fracture test was performed on the composite panel before the joining process, the adhesion between the skin plate and the resin core never failed before breaking of the resin core base material.

- Joule heat is likely to have transferred to the adhesive layer of the composite panel.
- The strength of the adhesive joining the skin plate and the core resin might have affected by heat.

**Conclusions**

1. High-speed solid-state joining of aluminum alloy stud on aluminum-resin composite panel was achieved.
2. The deformation of the crystal grain of the stud was hastened by higher discharge voltage and larger amount of heat input. Joining was achieved where this deformation occurred.
3. Heat produced by this joining method might have affected the strength of the adhesive layer joining the skin plate and the core resin of the composite panel. Further investigation is required to confirm this supposition.