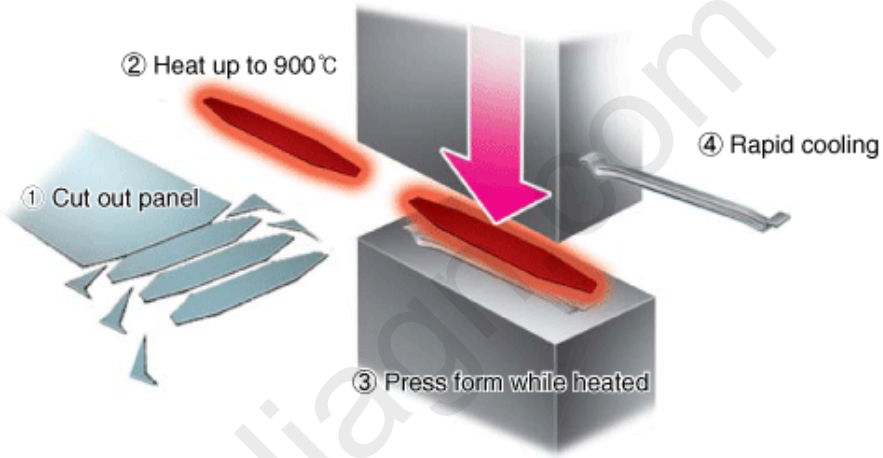
ULTRA HIGH STRENGTH(HOT STAMPED) STEEL REPAIR PROCEDURE

SUMMARY

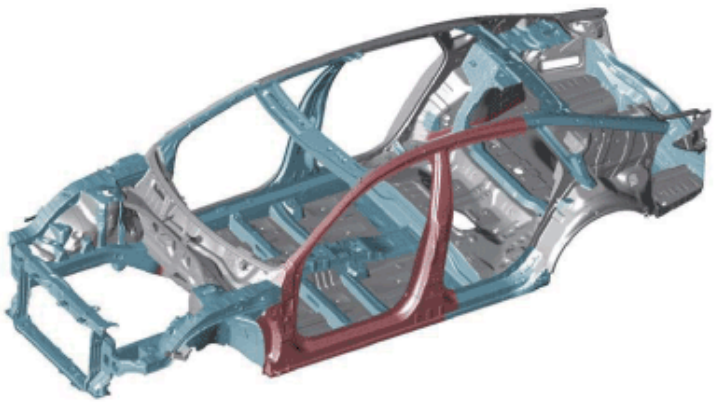
1. What is Ultra High Strength (Hot Stamped) Steel?
   This type of steel panel is made by reinforcing strength by heating the steel panel to high temperature, press forming and then rapid cooling to achieve light weight and enhance safety of vehicle. It is widely applied to members and pillar parts requiring ultra high strength.
   - Manufacturing Process of Hot Stamped Steel
     This steel is made by heating a steel panel of normal strength (340 MPa) to a temperature of 900°C and rapid cooling immediately after press forming to reinforce the strength to approximately 1,500 MPa.
     While heating, to prevent oxidation of panel surface, the steel alloy of Al (Aluminum)-Si (Silicon) is used. Alternatively, if Boron (B) is used to reinforce strength, this steel is called Boron Steel.



NOTICE

* MPa (Mega Pascal) : A unit of pressure; 1,500 MPa refers to strength withstanding pressure of 1.5 t per 1cm².

2. Properties
   In most cases, ultra high strength (hot stamped) steel will not be deformed (bent/twisted) from external impact, and once it is deformed, it cannot be corrected.
   Therefore, in case of deformation in parts with ultra high strength (hot stamped) steel among vehicle components, it must be replaced as an assembly.



Ultra high strength (hot stamped) steel

Application of ultra high strength (hot stamped) steel on K7 (YG)

NOTICE

By increasing the steel strength of each panel applied to body panel, the relative thickness of panel can be reduced, resulting in decreased weight from decreased thickness.
For example, vehicle models before K5 (TF) applied high strength steel of 1.6mm (9kg) for center pillar reinforcement panel and roof side rail. But vehicle models after K5 (TF) applied ltra high strength (hot stamped) steel of 1.2mm (5kg) for reduced thickness and weight, and enhanced passenger safety in the event of accident.

REMOVAL

As ultra high strength (hot stamped) steel, heat processed at a temperature of 900°C, has entirely different properties from ordinary body panels, the proper tools and materials should be used for processing and cutting damaged panels.

1. Tools and Materials
   Although there is not much difference in the tools and materials required for removal from general tools, ultra light alloy materials (drill bits and rotary bars) and belt sander paper are used for hole processing materials, and wheel cutter is used for panel cutting.
   * Ultra light alloy: Alloy made by compressing tungsten powder mixed with a small amount of cobalt and nickel powder.

   (1) Drill

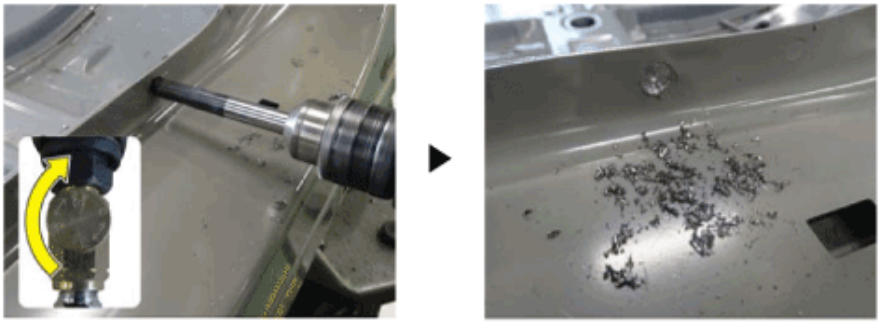
   - When removing spot welding point on ultra high strength (hot stamped) steel, reduce the number of rotations of drill by half from the maximum speed, and then gradually increase to find the optimum number of rotations while drilling.
   - Control the amount of air by installing air control valve onto the drill coupler connection to more effectively control the number of rotations of drill.

General air drill

Example of installing air control valve

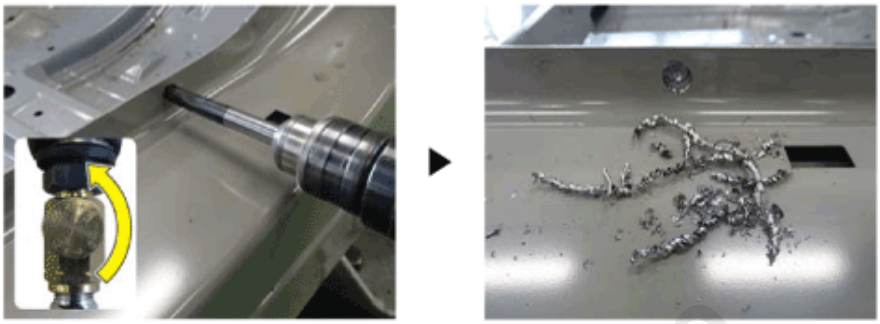
NOTICE

As general air drill is a high speed drill, the speed must be reduced when processing ultra high strength steel such as hot stamped steel. This is to maintain the maximum grinding power of drill bit by reducing the friction heat generated from grinding the panel. Medium/low speed drill can also be used



On high speed

Bits of metallic powder are generated.



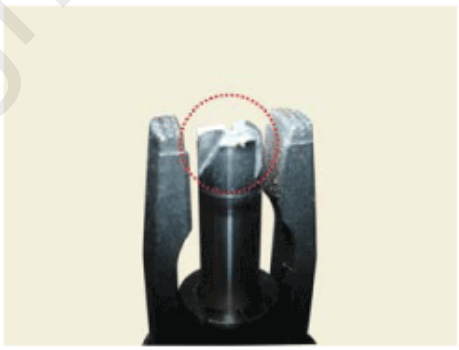
On medium speed

Panel strips are rolled out.

(2) Drill Bit

- Use double or triplex drill bits of carbide solid material.
- Be careful when processing holes, as the machining surface or blade end of carbide solid drill bit may get damaged if momentary force is applied due to interference of panel segment while grinding or excessive force is applied to drill.

Carbide solid drill bits



Damaged blade of carbide solid drill bit

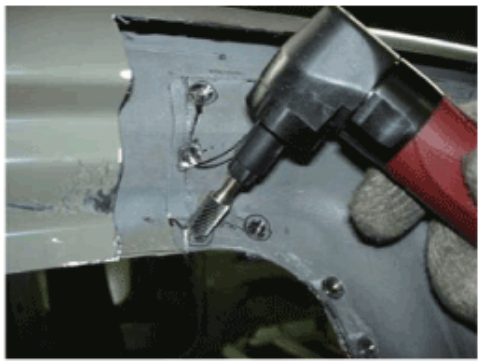
NOTICE

Carbide Solid Drill Bit
Carbide solid (alloy) is made by heating to a temperature over 1,400°C and compressing the mixture of tungsten powder and a small amount of cobalt or nickel. It has superior grinding performance at high temperature, but it can easily get damaged from impact. Therefore, to prevent damaging the carbide solid drill bit, stop processing just before perforating the hole, and finish off the hole processing with a general drill blade for more effective result.

(3) Rotary Bar

- In areas where it is not easy to use a drill, a rotary bar can be used.
- Unlike drills, rotary bar does not need to control speed. Grind the panel on the upper lateral side of the rotary bar.
- Rotary bar can be used to grind panel in a narrow space where drill cannot reach.
- As rotary bar does not have an independent safety device, it is essential to wear protective gear against metal segments generated from work.

Rotary Bar



Example of use

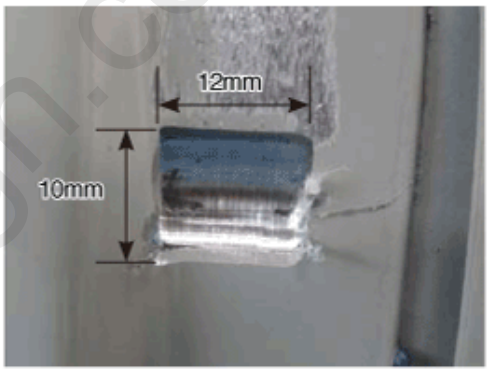
NOTICE

Rotary bars of various shapes and specifications can be used for processing metals. In particular, it can be used as a grinding material for effectively processing panels such as ultra high strength steel that are not easy to process.
Use the same or 1.0 mm wider rotary bar compared to the welding diameter.

(4) Belt Sander

- Belt sander can be used for processing welding zone of replacement panel with ultra high strength steel.
- It is effective to use a rough belt sander paper of less than #50.
- Panel processed by using belt sander gets wider than hole processed panel (10x12mm) by using drill (Ø8) or rotary bar (Ø9). As this may cause difficulty in rewelding, do not use on panel to be reused.

Belt Sander



Belt sander processing result

NOTICE

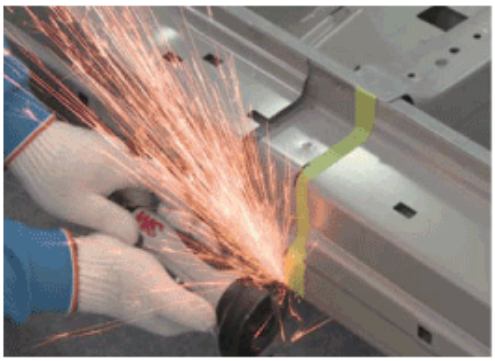
As the specifications for belt sander paper for removing welding point may differ according to the specifications for belt sander, check the specifications of tool before use.
Also, the ideal specifications for sand paper should be around #36, which is lower than common specifications of #50~#80.
#50
A square measuring 1x1 inch is divided by 50 evenly spaced horizontal and vertical lines, forming 50x50=2,500 frames through which 2,500 grinder particles pass.
Lower specifications represent larger particles or rough and faster performance.
For example, #36 refers to 36 grinder particles horizontally and vertically, totaling 1,296 particles. As it is made of approximately 1.9 times rougher grinder particles than #50, it is more effective in removing welding points.

(5) Wheel Cutter

- It is extremely difficult to remove ultra high strength (hot stamped) steel by using a general air saw (blade). Use a wheel cutter to cut out a panel.

English

Wheel cutter



Example of wheel cutter

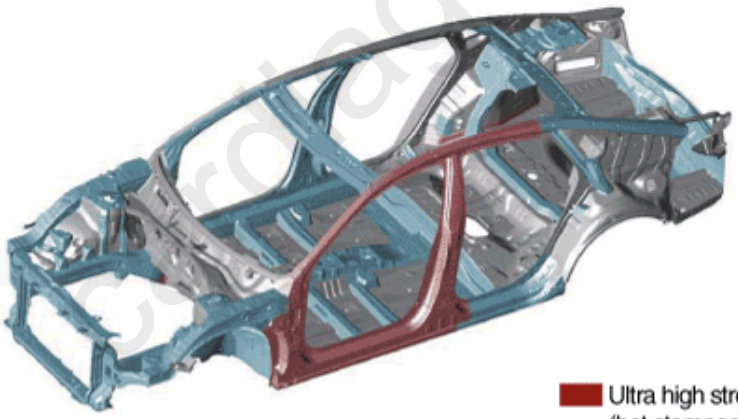
NOTICE

When removing ultra high strength (hot stamped) steel, cut out the panel according to the panel composition and adhesion area in advance to effectively remove it.
When using a wheel cutter for removing a panel, a device with a safety device (wheel cover) must be used.
Wheel cutter is made by compressing grinding materials to a thickness less than 1 mm. Be careful as it may break easily when excessive force is applied during cutting process.

ADHESION

Ultra high strength (hot stamped) steel can be attached by riveting or welding.
① When riveting, structural adhesive must be applied to the binding area to maintain the adhesion strength similar to that of spot welding.
② Basically, apply structural adhesive to the binding area before spot welding. MIG Plug welding can be performed if spot welding cannot be performed due to its structure.

- Adhesion method of ultra high strength (hot stamped) steel



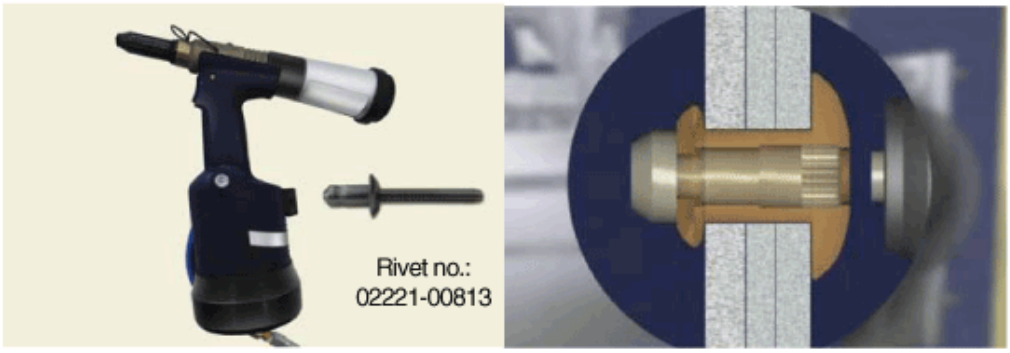
Riveting gun

Spot welder

MIG welder

1. Rivet Installation
   This is an effective adhesion method for ultra high strength (hot stamped) steel. As adhesion strength may differ according to rivet performance only and is irrelevant of the maturity of technician or welder performance, care should be taken in selecting the rivet. To maintain adhesion strength, perform riveting after applying epoxy adhesive to the binding area.
   - Rivet
     Use only the recommended product for riveting ultra high strength (hot stamped) steel.
     To process holes for installing rivet to body panel, use a carbide drill bit of Ø6.7 mm.

Riveting is possible only if the gap between the outer panel and reinforcement panel is at least 7.0 mm. Check th... space before assembling the panels.
※ Hemlok rivets and nG4 rivet gun are recommended for use on ultra high strength (hot stamped) steel.



Rivet and riveting gun　　Installed rivet

2. Structural Adhesive
Structural adhesive is applied on all welding and riveting points except MIG Plug Welding points. By doing this, the welding strength is supplemented and any noise and corrosion from the gap on the hole processed part can be prevented.
   - Adhesive Application
     Structural adhesive is hardened when the base material and hardener are mixed. Check that the base and hardener are evenly discharged before installing the nozzle as incorrect mixing ratio may cause decreased adhesive strength from defective hardening.

(1) Adhesive Composition
   - Two-liquid type epoxy adhesive is composed of base material and hardener.
   - •Use a mixing nozzle (with guide insertion inside nozzle) for even mixture of base material and hardener.

MOBIS serial no. :
HENPB-05055

MOBIS serial no.:
MMMPB08115

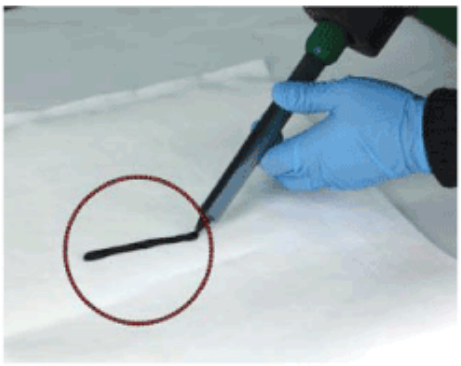
Mixing nozzle

NOTICE

Structural adhesive is mainly composed of epoxy and is also called epoxy adhesive.
The adhesive performance of structural adhesive may vary according to the temperature, roughness of surface to be adhered, and the oiliness of the surface. Remove impurities with adhesive cleaner after grinding.
Adhesives are sensitive to external temperature. If the indoor temperature of storage is below 20°C, preheat by using a heating box.

(2) Install and Check for Discharging
   - Always check that base material and hardener are evenly discharged before installing the nozzle onto structural adhesive.
   - After installing the nozzle, discharge a certain length (10 cm), then apply onto panel.

Check initial discharging of adhesive



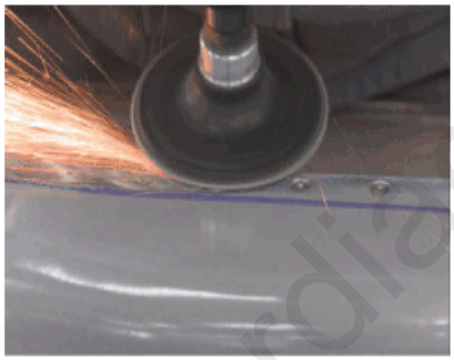
Check discharging amount after installing nozzle

NOTICE

The main reason for defective drying after applying structural adhesive is defective mixing due to difference in viscosities of base material and hardener.
Hence, before installing nozzle onto the adhesive, check that adhesive is properly discharged.
Also, discharge approximately 10 cm before applying onto panel. And after application of adhesion, complete panel adjustment within 90 minutes at 20°C.

(3) Preprocessing of Panel

- Remove paint and rust from panel by using a grinder.
- Remove any residual metal segments and paint dust by using air washer or cleaner (detergent).



Remove paint and contaminants

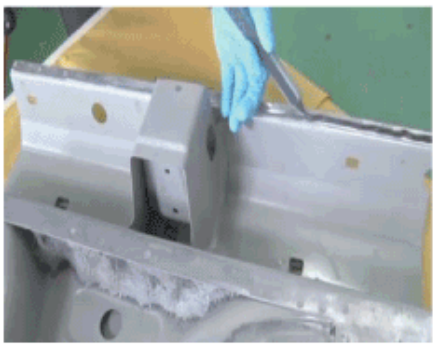
Panel washing (cleaning)

NOTICE

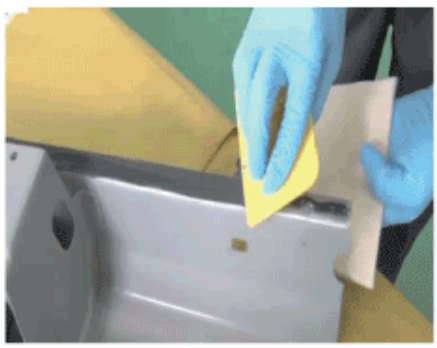
If structural adhesive is applied onto area of oil, paint layer or corroded (rusted) area, the adhesive strength may noticeably be deteriorated resulting in peeling phenomenon.
Hence, check the cleanliness of the panel before applying structural adhesive.

(4) Application (Primary Application)

- Evenly apply by filling the grooves and gaps on the panel to the thinnest possible thread.



Apply thinnest possible thread onto panel



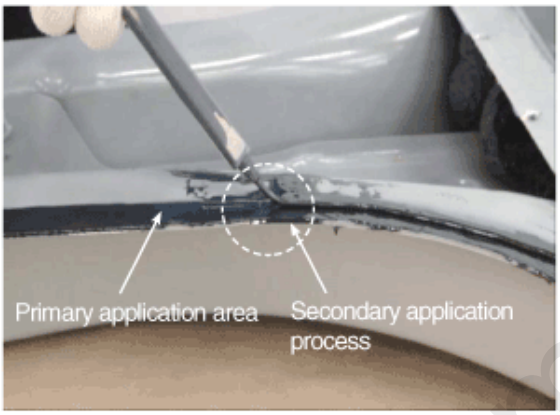
Even out by using a spatula.

NOTICE

When applying structural adhesive, fill the whole surface of the panel after grinding.
Always double check after applying structural adhesive because an area not filled with structural adhesive may peel off resulting in corrosion (rust).

(5) Application (Secondary Application)

- Reapply adhesive in continuous thread before the surface of evenly applied adhesive dries.
- The secondary application of structural adhesive is to provide actual adhesive strength. Apply a thicker thread than the primary application.



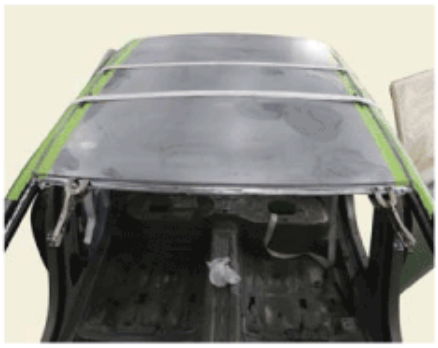
NOTICE

As more amount of adhesive is used for secondary application than primary application of structural adhesive, when replacing the structural adhesive during application, also replace the nozzle. When replacing the structural adhesive, always check that base material and hardener are discharged simultaneously before installing the nozzle.

(6) Adhesion and Drying

- The panel can be adjusted and moved within 60-90 minutes of attaching the panels by structural adhesive.
- Dry the structural adhesive for approximately 40 minutes at 65°C to dry effectively.

Clamp the flange area.



Fix with a belt on areas such as roof that cannot be clamped.

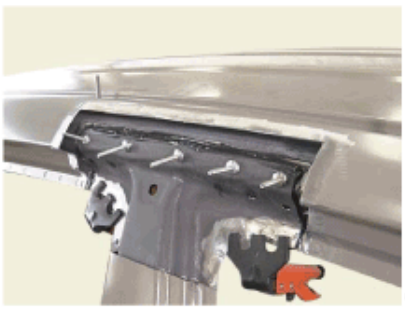
NOTICE

If the panels attached by structural adhesive are separated, the existing adhesive must be removed and reapplied. Therefore, complete all procedures before application of adhesive to prevent any unnecessary work. While attaching the panels with structural adhesive, immediately remove any adhesive exposed outside the panel. When using cleaner to remove adhesive, be careful not to directly apply it onto attaching surface.

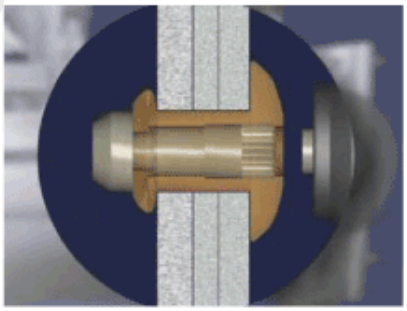
3. Structural Adhesive & Riveting Process
   - Riveting Process


① After applying the structural adhesive, fix the panel onto a new panel, and process holes by using carbide drill bit (Ø6.7).
* Check vehicle body dimensions from dimensions chart before processing holes.


② Apply structural adhesive to ultra high strength (hot stamped) steel.




③ Insert rivets (Ø) into processed holes and install by using riveting gun.
* Check for correct installation of rivets.

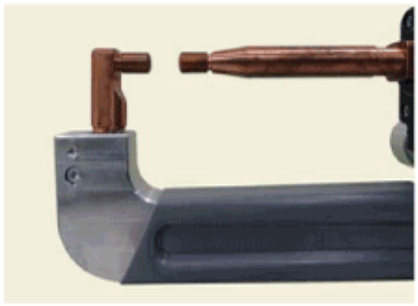
④ Check the panel mounting status after installing rivet.

4. Welding
Welding is a common adhesion method applicable to all steel types. As the welding property may differ according to welder performance and maturity of technician, care should be taken.

(1) Spot Welding
Spot welding is binding method by using electric resistance heat. The welding adhesion performance can drastically vary according to panel condition (painting, sealant, etc.) and cleanliness of welding arm (tip).
Before performing spot welding, always check for cleanliness of welding arm (tip) and remove paint from panel.

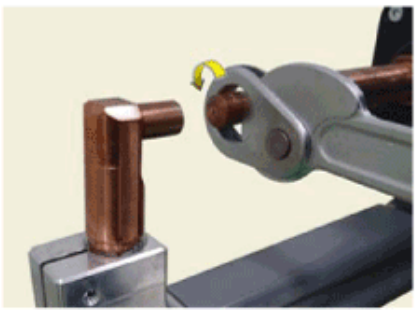
a. Check Welding Arm Condition

- Before performing spot welding, always check for painting on panel and cleanliness of welding arm (tip).
- Check the state of arm (tip) and replace the tip if it is severely contaminated.



Check for contamination of welding arm (tip)

Tip vise

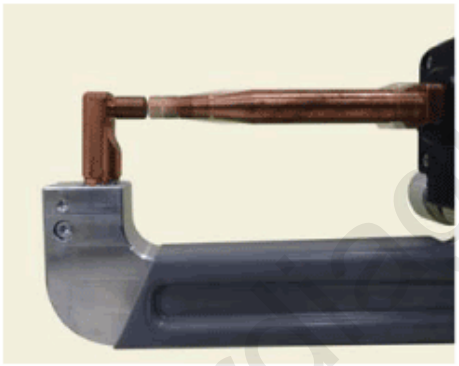


Welding arm (tip) replacement

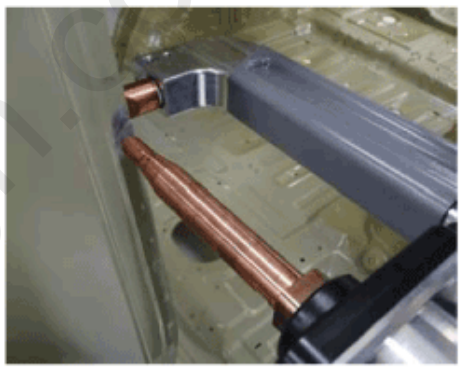
Welding arm (tip) replacement

b. Spot Welding Stage

- Spot welding is performed by ① pressurizing process to securely hold the panel, ② flowing electric current, and ③ compressing and attaching panels pressurized by electric resistance heat generated between electrodes.



Example of welding arm operation (pressurizing)



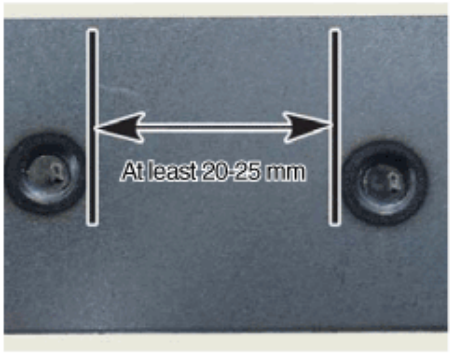
Example of panel welding (flowing current, setting)

NOTICE

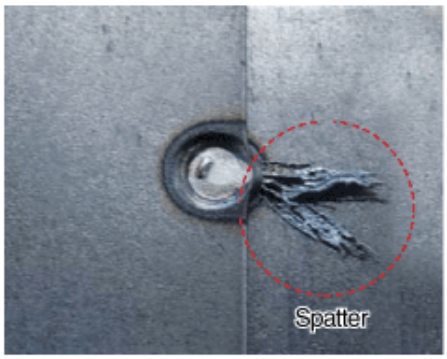
Spot welder uses electric resistance heat to perform welding, and its electric current is greatly influenced by the conditions of welding arm (tip) and panel.
If the welding arm (tip) is contaminated, cracks of welding area involved with a lot of spattering (of heated metal segments) may occur.
If the paint or sealant applied onto the body panel is not removed before performing spot welding, welding may not be possible due to electrical failure. Also, welding without removing corrosion (rust) or panel segments may result in cracks of welding point. Therefore, always check the processing condition of panel before performing spot welding.

c. Welding Point Location

- The minimum required weld spacing for 1.0 mm panel is 20 – 25 mm by considering the strength of panel.
- When welding close to the edge of panel, leave about 5 mm from the edge. If the panel is welded continuously toward the edge, a lot of spattering may occur, decreasing the welding strength, resulting in cracks of welding points.



Minimum distance 20-25 mm



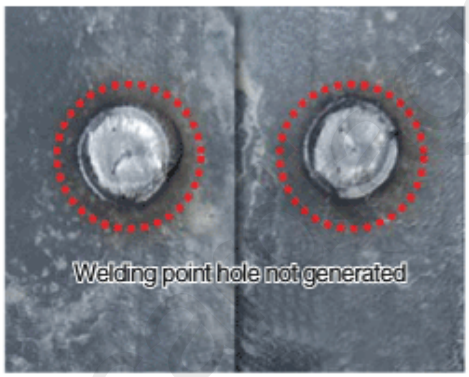
If spot welding is performed on the edge of panel, welding strength may decrease due to spattering.

NOTICE

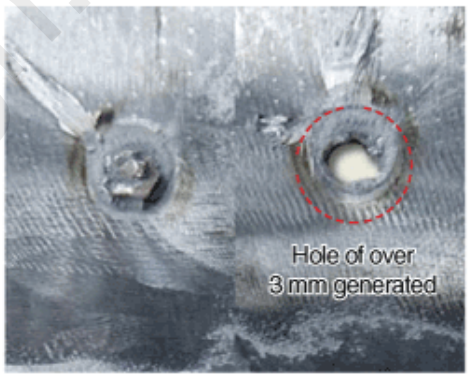
When spot welding, if rewelding is performed on previous weld points, satisfactory welding quality cannot be expected. Therefore, weld on areas other than previous weld points.
If the spacing is too close, the welding current may not melt the welding point, but instead flow through the prior welding point, creating a smaller welding point compared to a normal welding point, and resulting in decreased welding strength.

d. Checking Welding Quality

- Produce a testing panel for checking welding quality with an identical panel as the panel to be spot welded onto body.
- Separate the panel after spot welding onto the testing panel.
- The separated panel should be perforated with the minimum hole diameter of 3 mm.



Defective welding (Hole not generated)



Proper welding

NOTICE

As it is extremely difficulty to visually check the welding quality of spot welding, perform test welding on an equivalent panel and then perform peeling test.
If hole (perforation) is not created on panel after performing peeling test, it is welding defect. Adjust the spot welder again.

e. Vehicle Body Spot Welding

- The panel can be adjusted and moved within 60-90 minutes of attaching the panels onto vehicle body with structural adhesive.
- Immediately remove any structural adhesive exposed outside the panel during spot welding.
- Perform welding operation after checking the condition of welding arm (tip) of spot welder.
- Always check the condition of arm (tip) during spot welding operation, and immediately clean the arm (tip) in case of abnormality (deformation, excessive adhesion of spatter) before proceeding to welding.

NOTICE

When performing spot welding after applying structural adhesive, complete spot welding operation before the structural adhesive starts to dry.
Electric current may not flow once the structural adhesive has dried, resulting in deteriorated welding quality.
Hence, complete spot welding operation before adhesive starts to dry.
If the structural adhesive applied before spot welding operation has dried, separate the panel from the vehicle body, remove the structural adhesive and reapply.

(2) MIG Plug Welding
When welding ultra high strength (hot stamped) steel panel, perform MIG plug welding only to areas where riveting and spot welding cannot be performed. Be careful as the welding performance varies greatly according to maturity of technician.

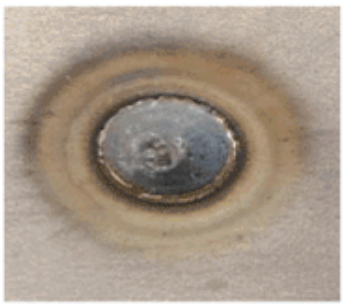
a. Adjustment

- Adjust the feeding speed and voltage control switch.
- For ultra high strength (hot stamped) steel, set to 1 level higher than general high strength steel welding condition, and perform test welding.

Adjust feeder speed

Adjust voltage


General high strength steel bead


Ultra high strength (hot stamped) steel bead

* Condition: Welding current of level 4 & wire feeding speed of 5 m/min for 1.0 mm panel thickness

NOTICE

When performing MIG plug welding onto ultra high strength (hot stamped) steel, remove any layer on panel surface before performing welding.
Also, as the bead may become very rough and uneven compared to general panel welding, perform test welding sufficiently before proceeding to main welding.

b. Welding Method

- When MIG plug welding, perform test welding on an identical test panel before performing welding.
- As cracks on welding points may occur from adhesive if epoxy adhesive is applied onto MIG plug welding points, to not apply epoxy adhesive.

English

MIG Plug welding process

MIG Plug welding installation

NOTICE

As the welding strength of MIG plug welding may greatly vary according to the maturity of technician, take sufficient time to configure (adjust) the welder before welding the vehicle body.
Do not grind off the welding bead generated from MIG plug welding ultra high strength (hot stamped) steel to guarantee strength.

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