2019 Award Nomination

Title of Innovation:

Bonded brackets on coated substrates

Nominee(s)

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Category:

Secondary steel

Dates of Innovation Development:

7/2015 – 7/2018

Web site:

Summary Description:

Welding for subsequent joining of brackets onto fully coated surfaces (for example repair purposes, modification of equipment or subsequent fittings) is not an ideal solution mainly because of the high efforts for preparation and post-processing as well as the heat load transferred into the surrounding steel as well as to the coating system. In order to decrease costs and time effort and not to compromise the corrosion protection system, an innovative process has been developed using high-performance adhesives. Brackets, and any attachments, are mounted directly to the top coat without harming coating or substrate. Part of the procedure is a non-destructive test that confirms the required adhesion to the particular coating system. The process steps of the developed procedure can be seen in Figure 1.

Figure 1: Process steps

Full Description:

(Please provide complete answers to the questions below. Graphs, charts, and photos can be inserted to support the answers.)

1. What is the innovation?

The developed procedure is a universal bracket with the following innovative characteristics:

- It can be applied on any (coated) substrate.
- It includes a non-destructive adhesion test for a preliminary compatibility check.
- A specially designed self-adhesive spacer tape enables an adjustable layer thickness and exact positioning with initial adhesion until the adhesive is fully cured.
- The dosing chamber guarantees precise dosing without excess material. Therefore, no rework is necessary which makes it applicable for projects with a demand for a high-class surface finish (for example yacht construction).
- The bracket is pre-fabricated (cleaned, grinded, primed and sealed) and can be applied directly onto the cleaned (coated) substrate without additional preparation.
- The curing process is independent from the surrounding atmospheric humidity and takes place also at low temperatures (≥ 5 °C).
- Robust process due to its high repetition accuracy.

2. How does the innovation work?

The process can be subdivided into six major steps, shown in Figure 1. The following working steps are part of the procedure:

1. Cleaning
    I. Cleaning of the coated substrate with a water/solvent-mix.
    II. Cleaning of the adhesion test dolly with a water/solvent-mix.
2. Preparation
    I. Application of the adhesion primer on the cleaned substrate surface.
    II. Fixing the test-dolly to the dried primer surface using a fast-curing adhesive.
3. Adhesion test
    I. Load application up to the pre-scribed threshold (e.g. ≥ 5 MPa) with a mobile adhesion-testing device.
    II. Removing test-dolly by targeted heating of the adhesive bond.
4. Pre-assembly
    I. Fixing of the pre-fabricated bracket to the primed and tested surface.
5. Adhesion injection
    I. Injection of the one-component adhesive into the dosing chamber.
6. Curing
    I. Curing of the adhesive or fast curing with additional heat.

In case the adhesion test fails, the coated substrate is locally decoated using a magnetic mask and a special grinding tool. The remaining process steps stay the same, but the bracket is directly connected to the underlying substrat material (normally steel).

The uncoated surface is completely covered by the bracket cross section with adhesive, and the bracket adheres to the bare steel, which leads to improved bonding strength.

3. Describe the corrosion problem or technological gap that sparked the development of the innovation? How does the innovation improve upon existing methods/technologies to address this corrosion problem or provide a new solution to bridge the technology gap?
Welding for subsequent joining of brackets onto fully coated surfaces (for example repair purposes, modification of equipment or subsequent fittings) is not an ideal solution, mainly because of the high efforts for preparation and post-processing as well as the heat load transferred into the surrounding steel as well as to the coating system (Figure 2). Using adhesives, these problems can be avoided.

Figure 2: Unwanted side effects due to mounting of brackets for subsequent fittings by welding.

The newly developed solution has the following advantages compared to the commonly used welding process:

- Negligible (almost no) heat load introduced into the coating or the substrate, resulting in no impairment of coating, steel and adherends.
- No post-processing.
- No containment needed around work area.
- The possibility of joining different material types.
- Avoidance of bimetal (galvanic) corrosion.
- 230V electricity supply is sufficient.

Additional benefits:

- Large-scale bonding to thin-walled parts.
- Elastic bond between substrate and mounted structure.
- Reduction of vibration.

4. Has the innovation been tested in the laboratory or in the field? If so, please describe any tests or field demonstrations and the results that support the capability and feasibility of the innovation.

The innovation has been intensely tested by the independent and accredited research facility Fraunhofer IGP in Rostock, Germany. The performed work covered a wide range of different tests to support the capability and feasibility of the innovation. The following work has been done:

Tests regarding effects of substrate contamination on the bonding strength. The following contaminations were simulated:

- Transport pollution
- Window cleaner
- Fuel
- Lubricants
- Salt water

Test regarding the optimal surface preparation method. The following methods were tested:

- Cleaning with isopropyl
- Cleaning with an isopropyl/water/aceton-mix
- Cleaning with above plus plasma treatment
- Cleaning with above plus flame treatment

The achieved surface condition was evaluated using:

- Contact angle measurements
- Roughness measurements
- Cross cutting test (DIN EN ISO 2409)
- Pull-off tests (EN ISO 16276-1)

Mechanical static and ongoing dynamic tests (Figure 3):

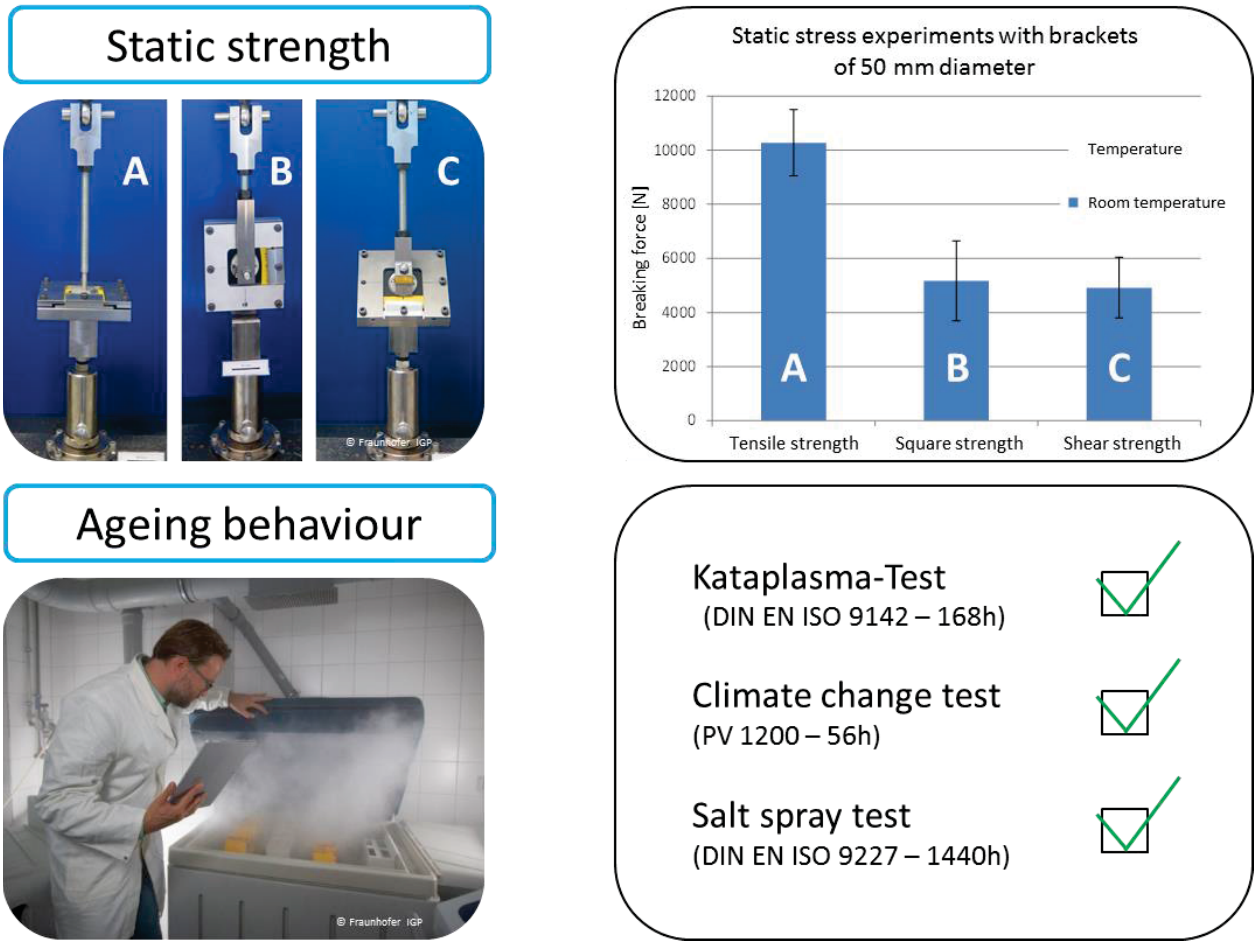

Figure 3: Results regarding static stress tests and accelerated aging.

5. How can the innovation be incorporated into existing corrosion prevention and control activities and how does it benefit the industry/industries it serves (i.e., does it provide a cost and/or time savings; improve an inspection, testing, or data collection process; help to extend the service life of assets or corrosion-control systems, etc.)?

The process can be incorporated by replacing welding processes in case of already coated substrates. Resulting benefits are:

- The existing coating protection system remains unharmed (No decoating and rework).
- Process times are substantially reduced.
- The necessity of quality management is reduced to a minimum.
- Changes regarding the notch effect class due to welding do not have to be accounted for.
- Resulting in an overall substantial cost saving.

6. Is the innovation commercially available? If yes, how long has it been utilized? If not, what is the next step in making the innovation commercially available? What are the challenges, if any, that may affect further development or use of this innovation and how could they be overcome?

The process has been intensely tested in laboratory and field application and is about to be used for commercial projects with different customers from the ship building industry and offshore platform builders/operators.

The process is ready-to-use on a bigger scale. Nonetheless, investigations into further improvements are still ongoing. Therefore, the already existing advantages compared to welding and other methods are expected to further increase.

The biggest challenge is the certification of the process. Since the top coat on different ships and offshore platforms mostly differs, each application case has to be checked and approved individually. Six standard coatings are qualified so far. Once enough experience is gathered, an overall certification with the DNVGL can be achieved.

7. Are there any patents related to this work? If yes, please provide the patent title, number, and inventor.

No