ThreeBond
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The Fourth-Generation Locking Agent for Screws: Gum-type Bond

Introduction

A variety of screws or bolts are used for connections in various industries. Loosened screws can cause serious accidents and so many kinds of locking methods are available.

Three Bond has offered three generations of screw-locking agents, all of which are widely used in our customers' production facilities to improve assembly efficiency:

ThreeBond 1400 series - first generation: volatile solvent screw-locking agent.
ThreeBond 1300 series - second generation: anaerobic screw sealant.
ThreeBond 2400 series - third generation: microencapsulated screw-locking agent.
All have the basic bonding function along with specific features.

Recent accidents, such as the collapse of a steel tower or the fall of a bolt from a large structure, have shown that anti-loosening is required not only for the manufacturing and assembly lines but also for large-diameter bolts. The requirements for the agent differ according to the environment used, such as working in rain in open-air environment, working under water, or repairing automobiles. Furthermore, improvements are expected for the sealing of pipe joints for ease of assembly, in addition to the original purpose of locking the threads.

In June 1999, Three Bond released the fourth-generation locking agent, a gum-type bond for screws, to meet these market demands, which differ from the requirements from the assembly line.

This issue introduces the gum-type bond and describes its excellent screw-locking and sealing functions and workability.

ThreeBond is abbreviated as TB hereafter.

Contents

1. Gum-type bond TB1450B and 1450C

1-1. Outline

Gum-type bonds, TB1450B and 1450C, are environment-friendly, solvent-free agents for locking screws.

The main characteristic of this kind of bond is its gum-like (rubber-like) form, a state between liquid and solid. This adhesive can be applied by winding around the object, which was not possible with liquid adhesives (Photo 1).

Also it contains microcapsules, which break when the screws are fastened and thus help to cure and lock quickly.

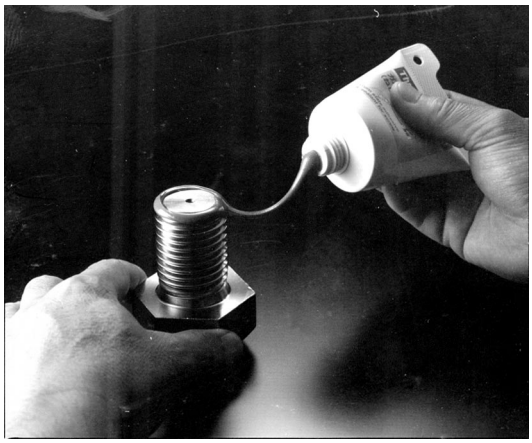


Photo 1. Gum-type bond

Type	Color	General guideline for handling temperature*	Content
TB1450B	Blue	5 ~ 30˚C	100 g
TB1450C	Orange	25 ~ 50˚C	100 g

* Use one of the two types, depending on the temperature of handling environment, for easier squeezing.

1-2. Characteristics

The gum-type bond has the following characteristics:

(1) It is an environment-friendly, solvent-free reactive locking agent for screws.

(2) It can be applied by winding it around the screws.

(3) It has excellent filling into thread clearance, offering good sealing.

(4) An excess can be removed easily (Fig. 1).
Solvent was necessary to remove excess liquid adhesive, but gum-like adhesive can be removed easily.

(5) It locks any metallic objects.
When the screws are fastened, the micro-capsules break, releasing the curing agent. The bond cures and locks screws of any metals.

(6) Micro capsules offer excellent preservation of their contents. In our tests, the contents have lasted for two years at room temperature.

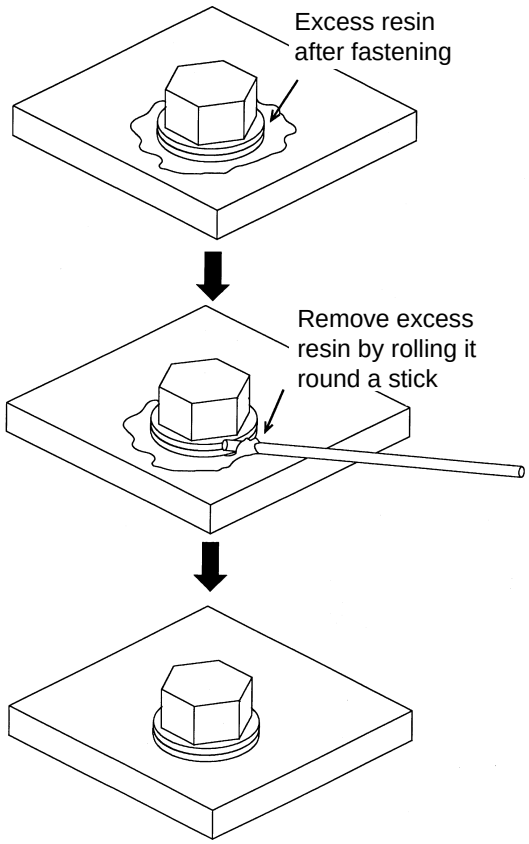


Fig. 1. Removal of excess gum-type bond

1-3. Curing mechanism of gum-type bond

Gum-type bond is composed of gum-like methacrylate ester that contains a curing catalyst, and capsules of curing agent.

When the screw is clamped, the shearing force breaks the capsules, releasing the curing agent for hardening (Fig. 2).

If the screw is not fastened, the capsules do not break, and so no curing occurs.

So curing occurs only when the screw is clamped.

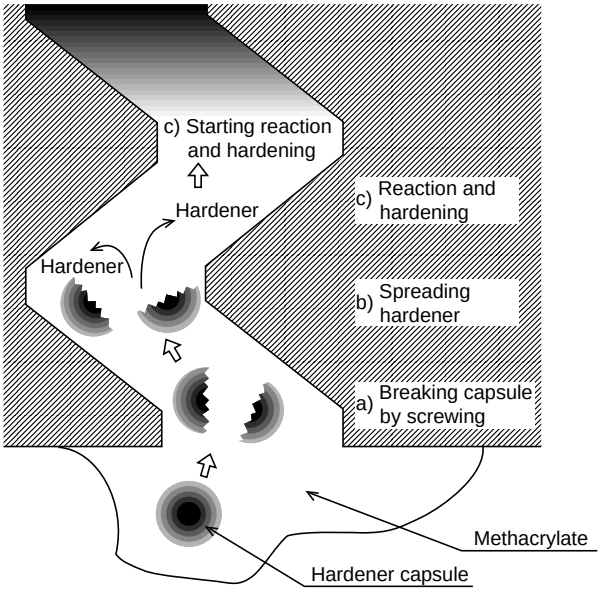


Fig. 2. Hardening mechanism

2. Improving the sealing effect

If a sealant has good resistance to deterioration caused by chemical effects or aging, its effectiveness depends on whether it is densely filled in the clearance between the screw threads and whether it is well bonded to the threads.

In simple words, good sealing can be obtained by filling the sealant in the thread clearance densely and by improving the strength of the bond between sealant and threads.

2-1. Methods for sealing screw threads

Roughly speaking, there are two basic methods for sealing a screw, as shown in Fig. 3. One is to fill the thread clearance with nonreactive sealants, and the other is to bond with reactive agents, such as the anaerobic sealant or the microcapsule thread-locking process (called “the MEC process” hereafter). The latter actually provides sealing not only by adhesion but also by filling.

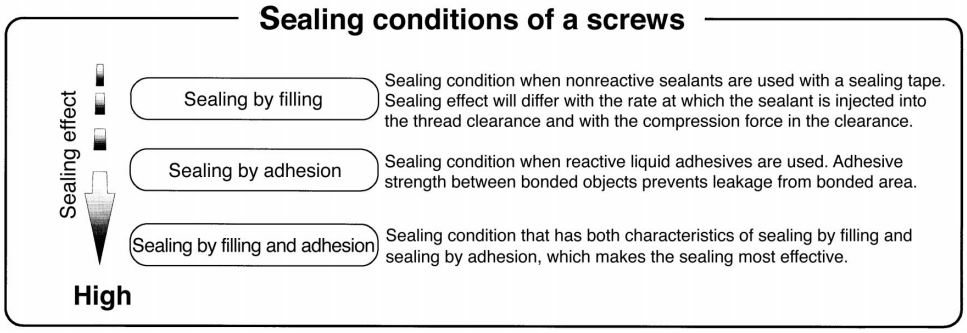


Fig. 3. Sealing conditions of screws

2-2. Improving retention in the thread clearance

The gum-type bond, as Fig. 4 shows, fills and stays in the thread clearance with its elasticity, so is not easily squeezed out as regular liquid adhesive is.

So it gives excellent sealing.

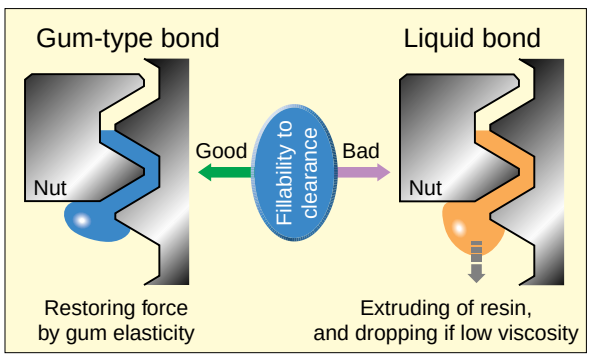
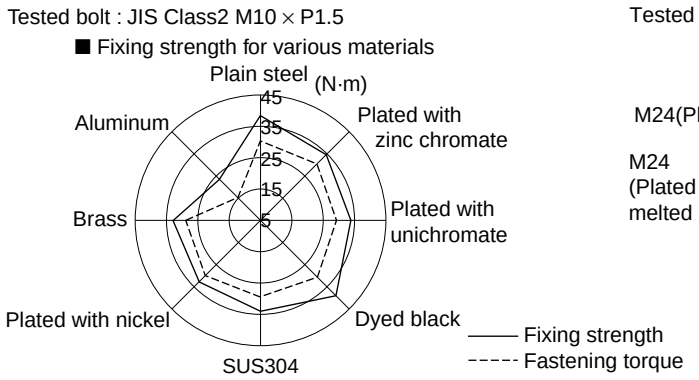


Fig. 4. Difference of retention in the thread clearance

3. Physical property of the gum-type bond

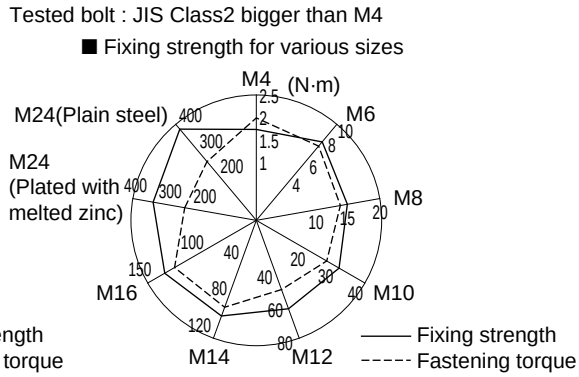
3-1. Fixing strength by material

The gum-type bond provides fixing strength regardless of the type of metallic materials, in the same way as the MEC process.



3-2. Fixing strength by size

Gum-type bond has enough fixing strength for M4-size bolts, but it is best suited for M8 size or bigger because it is easier to apply to bigger bolts.



3-3. Fixing strength at different temperatures

The break loose torque of the bond was measured at different temperatures after reaction curing on a bolt. The gum-type bond maintains its fixing strength at 150˚C (Fig. 5 and 6).

Note: At 180˚C, the recorded break loose torque is lower than the fastening torque, but the bonding strength recovers when the temperature decreases.

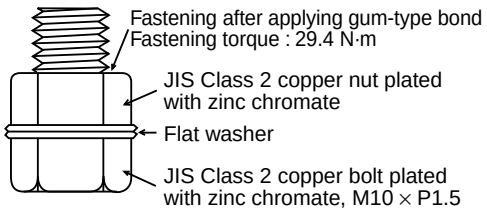


Fig. 5. Tested bolt

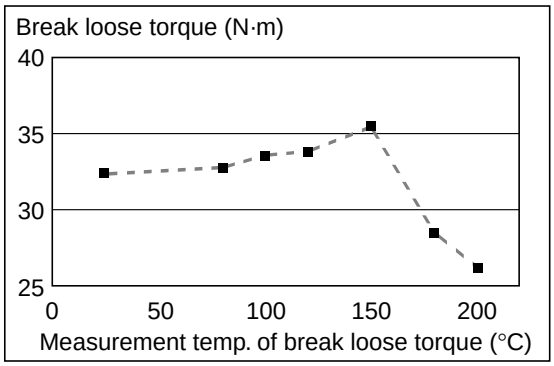


Fig. 6. Break loose torque at various temperature

3-4. Resistance of fixing strength and sealing effect to heat

In heat deterioration tests, screws sealed with gum bond were subjected to temperatures of 100˚C and 150˚C for 30 days. As the results show (Figs 7-9, Table 1), neither fixing strength nor sealing effect deteriorated.

A leakage test was carried out at pressures up to 10 MPa, using the apparatus below.

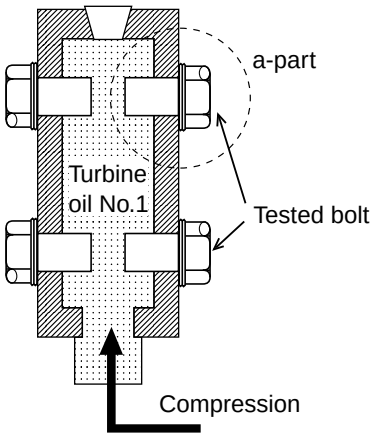


Fig. 7. Total view of sealing test

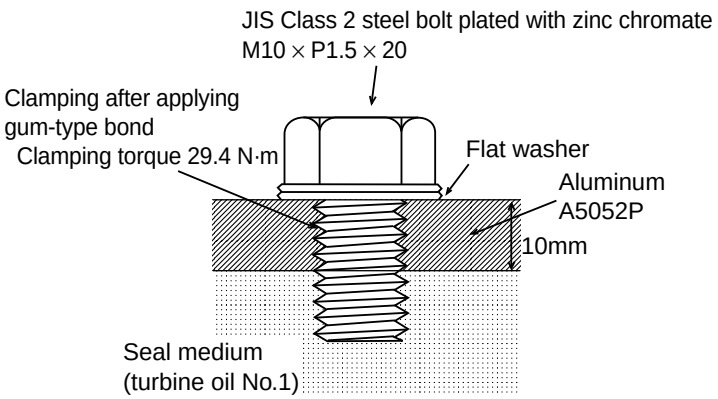


Fig. 8. Enlarged view of a-part (in Fig. 7)

Table 1. Sealing effect after thermal degradation test

Sealing effect	Initial (0 day)	10 days	30 days
100˚C	10MPa Passed the sealing test	10MPa Passed the sealing test	10MPa Passed the sealing test
150˚C	10MPa Passed the sealing test	10MPa Passed the sealing test	10MPa Passed the sealing test

3-5. Fixing strength and sealing effect against chemicals

To simulate an automotive environment, a test piece was immersed in engine-cooling water and engine oil for 30 days.

No deterioration was observed in either fixing strength or sealing effect (Table 2, Fig. 10).

Table 2. Sealing effect after chemical immersion

Sealing effect	Initial (0 day)	10 days	30 days
Engine coolant (50%aq) Immersion temperature100˚C	10MPa Passed the sealing test	10MPa Passed the sealing test	10MPa Passed the sealing test
Engine oil Immersion temperature120˚C	10MPa Passed the sealing test	10MPa Passed the sealing test	10MPa Passed the sealing test

3-6. Sealing test with various bolts and plugs

Sealing tests were carried out with various bolts and plugs. The gum-type bond exhibited excellent sealing in all of the tests (Table 3).

3-7. Fixing strength with various thread precisions

The fixing strength was measured using internal threads of JIS Classes 1 to 3 (Fig. 12), for variations in the gap at the external thread valley. The gum-type bond showed stable fixing strength regardless of the precision of the internal threads.

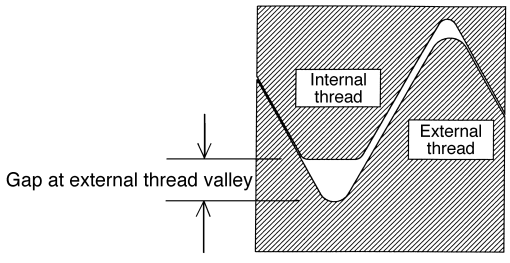


Fig. 11. Condition of valley gap

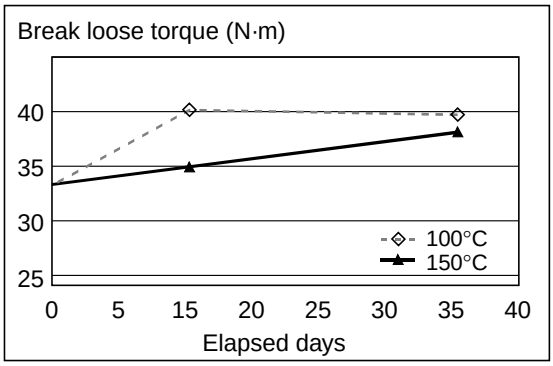


Fig. 9. Fixing strength after thermal degradation test

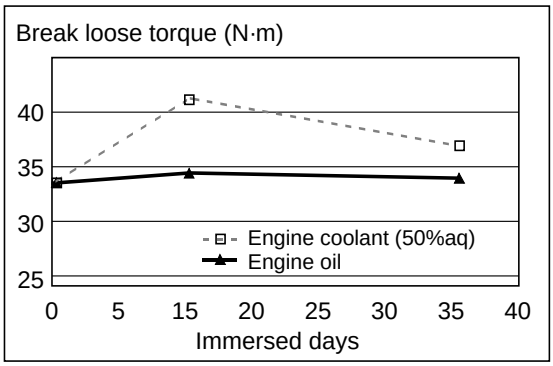


Fig. 10. Fixing strength after chemical immersion

Table 3. Sealing effect for various bolts and plugs

Tested bolts and plugs	Result of the sealing test
M10 bolt	10MPa Passed the sealing test
PT3/8 plug	10MPa Passed the sealing test
PT1/2 plug	10MPa Passed the sealing test
PT3/4 plug	10MPa Passed the sealing test

* After 24 hours hardening at 25˚C, we checked for leaks by increasing pressure 1 MPa/min up to 10 MPa.

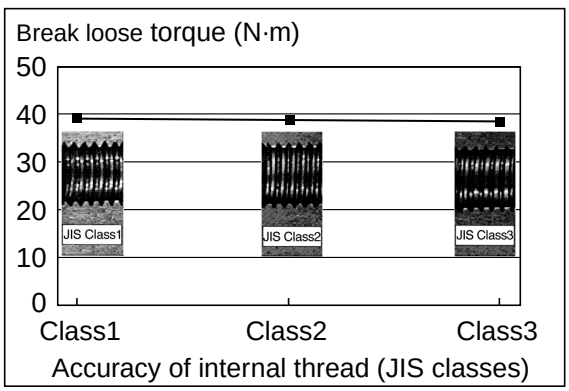
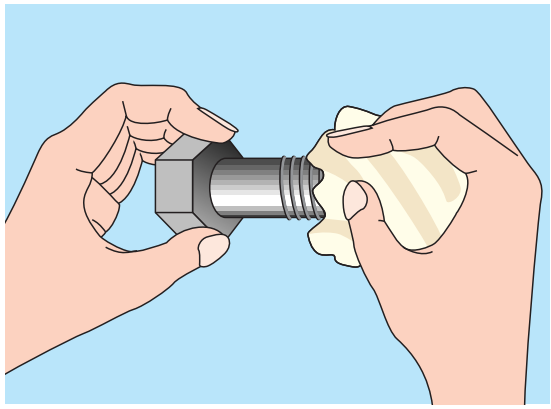


Fig. 12. Break loose torque for various screw accuracies

4. Procedures for applying gum-bond

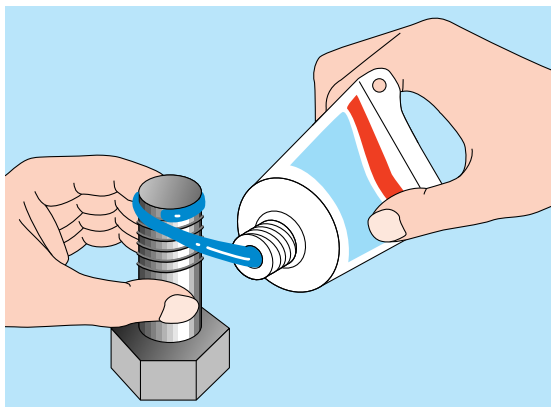
Degrease the threads

Using a cloth, remove oil and machining debris from the threads of bolts and pipes. Then degrease the threads with solvent.



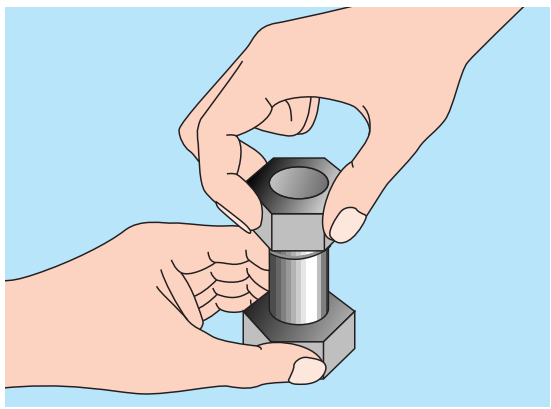
Wind the gum-type bond around the threads

Squeeze the bond out of the tube. Pulling gently, wind the bond around the threads 2 to 3 times.



Fastening

Fasten the nut (or socket).



Process is complete

5. Notes

a. Excessive sealant

The gum-type bond cures only when a screw or a bolt is clamped. Any excessive sealant does not cure, except where pressure is added, as at the seating face of a bolt.

If excess sealant remains uncured on internal threads, (such as where pipes are joined), it might flow and clog the filters.

To prevent excess sealant from remaining on internal threads, leave the first one or two of the external threads free of locking agent.

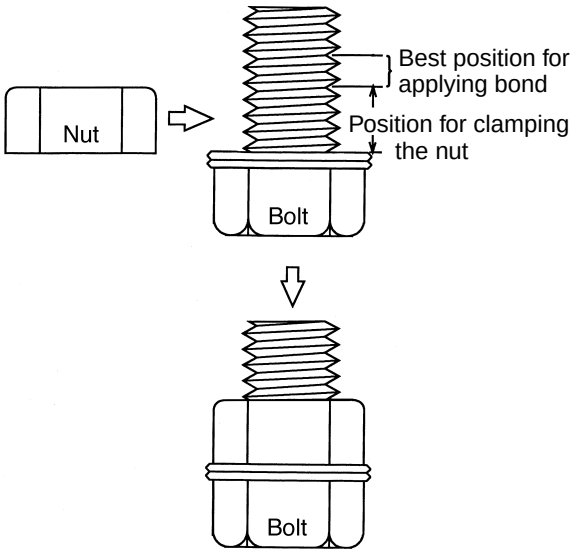


Fig. 13. Best position for applying bond

b. Degreasing

If oil or water is present on the thread, the gum-type bond will not adhere. Make sure that the threads are degreased sufficiently.

c. Thread clearance

When the clearance between the internal and external threads is too large, the microcapsules will not break, and therefore the gum-type bond will not cure.

This results in curing failure. Check the thread clearance before applying sealant.

d. Adherend materials

Some plastics and rubbers change their properties when in contact with adhesives. Check the possible influences, such as cracks, dissolution, swelling, and whitening, beforehand. Do not use the bond for wood; it will not cure.

6. Conclusion

By combining basic Three Bond technologies--microencapsulation, acrylic adhesives, and sealing methods--the gum-type bond has been developed. It supports new applications, easier handling, and improved performance.

Besides expanding the grades and features to offer a wider range of applications, we will continue to develop new screw sealing products, improving the anti-loosening and sealing functions, and also supporting the environment and recycling concerned features.

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ThreeBond TECHNICAL NEWS

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