

Advantages of Stainless Steel Fastener Application in Construction

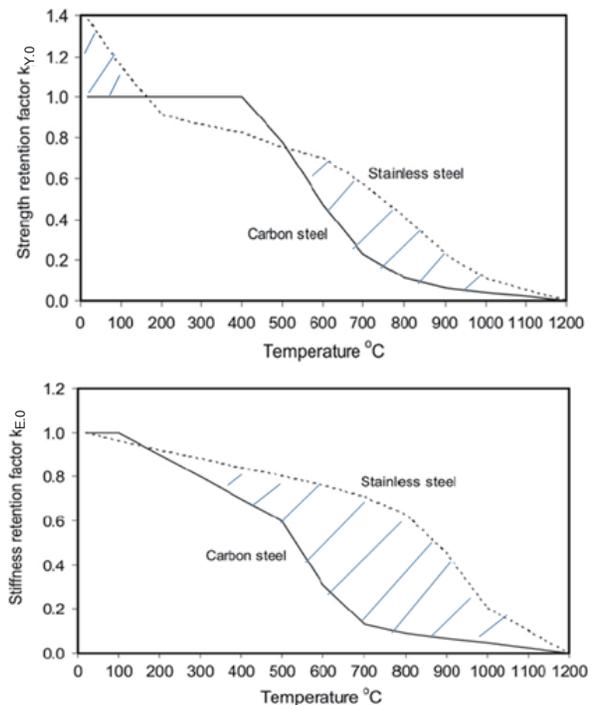
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Features of Stainless Steel Fasteners

Stainless steel is a kind of special steel. In general, it is an iron-based alloy mixed with chromium of more than 11.5%. It could be divided into 5 categories based on its alloy contents, namely, Cr-Ni-Mn 200 series, Cr-Ni 300 series, Cr 400 series, low Cr 500 series and precipitation-hardening 600 series. Because it features corrosion resistance, antibiotic, heat resistance, flame retardance, hygiene, better appearance and long service life, it is the priority selection in most industrial applications, including construction, communication, aero-technology, nuclear engineering, machinery, automobiles and vessels.

The advantage of stainless steel fasteners applied in modern construction is fully developed. Firstly, stainless steel is a high strength alloy, so its lateral loading strength is 20% higher than that of carbon steel fasteners. Their strength and rigidity under temperature variation is as shown in **Fig.1**. The oblique line means the portion of stainless steel that has better performance than carbon steel. Secondly, the corrosion resistance of stainless steel comes from chromium because it could form a thin, tough and invisible chrome oxide film on the surface of fastener when contact with oxygen, and protects it from the threat of environmental corrosive factors, such as humidity and acidity.

Fig.1 Strength and Rigidity of Carbon Steel and Stainless Steel Fasteners Under Temperature Variation



Data source: N.R. Baddoo, "Stainless steel in construction: A review of research, applications, challenges and opportunities"

Grades 304, 305 and 306 are most common applied stainless steel fasteners in construction; all of them belong to austenitic stainless steel, because of the nickel and chromium elements and nonmagnetic feature, it will not be hardened after heat treatment. The corrosion resistance offered by grades 304 and 305 stainless steel is sufficient to resist most environmental corrosive factors, but not for exposing to saline water environment. In comparison, grade 316 could provide better protection under the same condition because its nickel and molybdenum contents are 2-3%

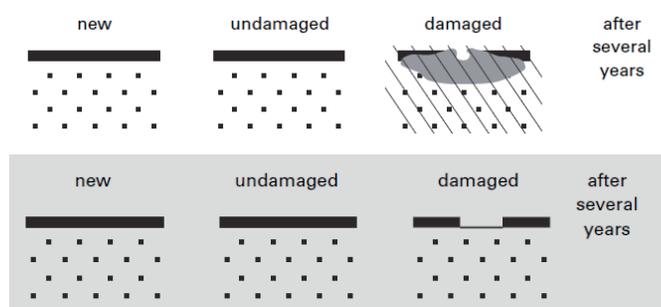


higher than that of 304 and 305. In general, major concern for fasteners used in the exterior of construction is its corrosion resistance, and grade 316 is a better choice under such consideration. As for fasteners used inside the construction, though rarely exposed as the outer parts, its structure and supporting strength is still important, so fasteners with grades above 304 are applied.

Advantages of Applying Stainless Steel Fasteners in Construction

Theoretically, there are two options to enhance the corrosion resistance of fasteners used in construction, especially for external use, one is through material selection such as choosing stainless steel, and another is surface treatment such as hot-dip galvanizing. Fig.2 compares their difference before and after use. It shows that the internal part of carbon steel fastener with surface treatment is corroded after several years and a qualitative change occurred in the contact face of corrosion, which damaged the internal structure of the fastener. In comparison, the stainless steel fastener also corroded after several years, but its internal part remains intact with the protection of chrome oxide film.

Fig.2 Comparison of Surface Treated Carbon Steel Fasteners and Stainless Steel Fasteners After Use



Data source: SFS Intec

When newly installed inside the construction, there is no significant difference in corrosion resistance, but when installed outside, they are affected by factors that cause metal corrosion, such as high humidity, salinity and temperature. Normally, when the environmental temperature increases 20°C, the corrosion speed will be doubled. As for the users, if there is no big difference in costs of purchasing, installation and maintenance, stainless steel fasteners are the preferred option for the construction because they are better in various aspects, such as warranty, yield rate, service life and surface maintenance.

The environment is changing rapidly, so green and durable building is becoming a tendency. Table 1 explains the

reasons why the stainless steel fastener is a better choice from environmental and operational aspects.

Table 1. Reasons for Choosing Stainless Steel Fasteners

| Reasons for Choosing Stainless Steel Fasteners | |
|--|--------------------------------------|
| Operational aspect | Environmental aspect |
| Production factors of common galvanized or stainless steel are the same | High humidity |
| Request to guarantee that quality of the product will not be failed by a single fastener | Significant rainfall |
| Will the powder resulted from the corroded fastener damage the surface of the product | Geographic wind with higher salinity |
| Customer requests environmental protection and long service life | High temperature |

Data source: Metal Industries Research & Development Center (MIRDC)

Some simple precautions shall be taken when applying stainless steel fasteners to construction. First, they shall be stored in a dry environment before installation to prevent from contact with air, dust or salinity residue. Second, waterproof adhesive shall be applied in installation. Because humidity is a threat to wood, preservative treatment like CCA (Chromated Copper Arsenate), ACQ (Alkaline Copper Quaternary) and SBX (Sodium Borate) is applied to prevent it from corrosion. However, these preservative processes contain chemical elements that could corrode fasteners, so fasteners like hot-dip galvanized fasteners able to against chemical corrosion shall be used in such installation, and stainless steel fasteners are still the best choice. Finally, it is better to paint or wash clean the coating after installation as soon as possible. For example, it is inevitable for salt particles or residues to stain on fasteners in coastal constructions. Consequently, when they are in contact with paint after installation, slight red stain will exude and pass through the coating surface, and affect the appearance and efficiency.

Construction Product Specification Certification is Required for Corrosion Resistance of Constructional Stainless Steel Fasteners in Europe and America (Code Approval)

Stainless Steel Fastener shares 20% of the fastener market in Taiwan, and more than 60% are exported mainly to Europe and America. Most of them are applied to basic industries, including railway, transportation and construction. In Europe and America, they have detailed regulations on the test of corrosion resistance of constructional fasteners and suppliers shall have more understanding to them.

USA- ICC-ES Series Certification Reports, AC257

For example, suppliers shall have the evaluation report issued by ICC when selling constructional fasteners in the United States. It is to certify that the corrosion resistance and strength of fasteners could support common construction when used in the exterior of ACQ treated timber. After 2009, ICC considered that ACQ evaluation method is out of date and replaced it with another test certification AC257, which is stricter and not limited to ACQ but applied to all timber treatments. It requests fasteners for timber treated with paint pressure shall be hot-dip galvanized and compared with other non-typical paint in use. Hot-dip Galvanized Fastener is taken as the criterion (ASTM(Note*) A153) in test, if the fastener provided to ICC has the same or better test performance, it could have the evaluation grade of AC257.

Note: ASTM is the abbreviation of American Society for Testing and Materials. It became independent of International Association for Testing Materials, IATM in 1902 at the 5th annual meeting of IATM. The criterions made by it are granted by most countries now.

Canada – NBC, CSA 086-09

There are two constructional fastener standards in Canada, one is NBC 9.23.2.2 (a guideline for fasteners in wood structure construction) and the other is CAS 086-09 4.3.4.2 (analyzing construction products based on engineering design dynamics). Instead of following ICC's AC257 test certification, NBC adopts the salt spray test according to ASTM B117. It is to place fasteners in salt spray test equipment for several hours and observe if its development could meet ASTM B117 when reaching certain corrosion condition. However, the major problem of this method is the uncertainty of environment. Even the test is passed, its duration and effectiveness still vary with the actual applications in environment. Another test criterion ASTM G198 is similar to AC257. It tests fastener's corrosion resistance in chemical treated timber. The test methods is to insert the fastener to chemical treated timber and expose to high humidity environment for preset time, and then compare its corrosiveness with a standard fastener.

EU - Eurocode 5, CE Marking

Specifications, strength, properties and corrosion resistance of constructional fasteners in EU are regulated

by Eurocode 5 (EC5) (EN1995.1.1: 2004 Design of Timber Structure), effective from March, 2010. **Table 2** is the suggested classes for fastener materials. If the test result is confirmed to EC5, the CE marking is granted and the product is allowed to be sold in EU. EC5 requests the minimum service life of fasteners is 50 years for common construction, 10 years for temporal construction, and 100 years for permanent constructions like monuments and bridges. Other specification like EN14592 is for material and coating applications, and ISO12944 is also adopted as a test criterion for fastener corrosion resistance by EU as it relates to the test of expected service life of metal with coating application under various environmental conditions.

Table 2. Eurocode 5 Suggested Classes for Fastener Materials

| Class | Eurocode 5 Service Classes | | |
|--------------------|---|---|---|
| | 1 | 2 | 3 |
| Humidity | ≤ 12% | ≤ 20% | > 20% |
| Environment Icon |  |  |  |
| Suggested Material | No | At Least Being Galvanized | Stainless Steel |

Data source: ITW Industry

Conclusion

Stainless steel performs very well in corrosion resistance, strength and antibiotic. When a fastener is made of this material, its unit price will be 5-10 times higher than that of common carbon steel fasteners, based on its material class, specification and usage. Because of its corrosion resistance and durability, the importance of stainless steel fastener is increasing in construction application. In general, high salinity, temperature and humidity are all external factors needed to be considered in corrosion prevention of fasteners, and chemical treatments like ACQ on timber shall also be considered when installing fasteners to timber. This is also the reason why stainless steel fasteners get more attention than galvanized fasteners. Furthermore, when exporting constructional fasteners to Europe and America, it is required to pay attention to test regulations relevant to construction products. For relevant regulations, refer to ICC of United States, NBC of Canada and Eurocode 5 of EU. ■

References

SFS Intec, Corrosion Brochure 2010
www.elsevier.com, "Journal of Constructional Steel Research"
www.itw-industry.com
www.constructioncanada.com
 GRK Fasteners