WHITE PAPER

Analyzing the performance of metal barb Ty-Rap® high-performance cable ties versus all-plastic cable ties under extreme conditions

Among industrial and commercial users, it is expected that cable ties will perform up to their UL-rated limits for attributes such as rated load limits and temperature range. Unfortunately, that does not help to determine which tie might be the most reliable in all conditions.

So, what is a cable tie, and why and where is it used? Part of a broad family of fastening products, a cable tie consists of a flexible band and locking head. These products are most commonly made from plastics such as nylon but are available in a range of materials for a variety of applications and needs. The reason a cable tie has become a ubiquitous item across nearly any industry is because of its versatile use. The flexibility to bundle and secure items is helpful in applications ranging from heavy industry to backyard gardens. Because of this wide use, the cable tie industry has evolved to serve a variety of customers and needs.

With many options available, which design is best suited for what application? Which tie, for example, will hold the highest load before breaking in conditions of extreme cold or heat? Or after intense UV aging or exposure to fluctuating humidity? Or, a related question that is of great concern for highly critical applications — which ties will simply slip when they fail, and which will break catastrophically and shed debris into surrounding areas?

Such questions are of critical importance in industries where a cable tie failure may contribute to a system failure with expenses that exceed the initial cost of a premium fastening product. Cable tie failure can mean loose wires or foreign object debris, which in rail or automotive equipment, or in a food and beverage plant, can result in critical equipment failure or expensive product contamination. Extreme cable tie performance is also important in situations where replacing a failed tie may be much more expensive, in terms of labor costs, than the tie itself. In arctic oil rigs, for example, or on ships at sea, the cost of a single minute of nearly any trade professional is typically more expensive than the savings gained by sourcing low quality commodities.

To more accurately measure reliability in extreme conditions, we subjected two of the most popular sizes of Ty-Rap high-performance cable ties with stainless steel barbs to a series of tests-to-failure and compared their performance to the same tests performed on nine varieties of all-plastic cable ties with molded-in nylon barbs. All of the cable ties used for these tests were made of nylon 6.6, which is the material typically used in the industry for general-purpose ties. Nylon is a hygroscopic material (a substance that absorbs or releases moisture from

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and to the surrounding environment), so its strength and characteristics can be significantly affected by heat and humidity. While variations in chemical formulation can mitigate or accentuate these effects to some extent, the difference in performance characteristics among various brands of ties is more a function of their physical design than of their chemical makeup. In these tests, each brand grouping of ties performed quite similarly to ties of the same make, particularly in the manner in which they failed but varied significantly from ties of other brands.

It is worth noting that Ty-Rap cable ties are also available in materials other than nylon that are specifically designed to remain more resilient in the tough conditions caused by temperature fluctuations, dry conditions, UV exposure or other extremes. Other brands also offer ties made with some materials other than nylon. None of the alternative materials were used in these tests.

Metal barb vs. all-plastic product differences
First patented in 1958 by Thomas & Betts, now ABB Installation Products Inc., the Ty-Rap metal barb cable tie utilizes a marine-grade stainless steel barb embedded in an oval head to grip a relatively smooth tie surface. The stainless steel barb is designed to “bite” into the strap of the tie when fastened to provide a firm lock that can be precisely adjusted for the application.

By comparison, all-plastic ties use a nylon pawl in the head that ratchets into indentations in the tie’s strap surface to achieve a grip. The tie, head and pawl are formed in one piece during the injection molding process The mechanical lock of the metal barb in Ty-Rap cable ties is designed to deliver several key benefits. The corrosion-resistant stainless steel barb locks permanently into the strap body to provide a reliable hold that is more resilient to environmental extremes. Each tie is infinitely adjustable, since the barb does not need to fit into a pre-designed ratchet indentation in order to achieve its lock. The smooth, solid construction results in a tie strap that is inherently stronger, since there are no ratchet indentations to introduce thinner weak spots. These tests were designed, in part, to test those assertions.

General test results
Under extreme, extended heat, humidity or long-term UV exposure, Ty-Rap metal barb cable ties generally performed favorably when compared to other brands. In general, one could conclude that Ty-Rap cable ties exhibited superior qualities of reliability under extreme conditions. The modes of failure were important as well. Ty-Rap metal barb ties tended to simply slip once they reached their failure points, but they remained intact, allowing no debris to leave the tie. All-plastic ties more commonly broke catastrophically, throwing debris into nearby areas.

Conclusions
Based on the results of the tests conducted, Ty-Rap metal barb cable ties often outperform other brands in key areas such as high-heat environments, UV exposure and cold weather. Ty-Rap metal barb cable ties performed at almost twice their rated load after 5,000 hours of high-heat exposure, when some other brands failed to perform at all. Ty-Rap TY27MX metal barb ties performed similarly under UV exposure, holding almost twice their rated load when another leading brand failed to withstand the same 5,000 hours of UV exposure. When it comes to cold-weather tie installations, Ty-Rap cable ties performed with 100% success in temperatures down to -60°C. Several other brands failed in temperatures as “warm” as -20°C. Also worth noting is that Ty-Rap metal barb cable ties very rarely fail in a manner that creates additional debris or sheds plastic into the environment. All-plastic cable ties often fail catastrophically, casting their plastic pawl or pieces of cable tie into the environment.

Test overview

We performed four sets of tests on the subject group in UL-approved labs in ABB facilities.

Reliability tests

Test 1 — Low installation temperatures
Ten ties of each variety and aluminum mandrels of three sizes were chilled in a controlled chamber to -20 °C, -40 °C, -50 °C and -60 °C (-4 °F, -40 °F, -58 °F and -75 °F) and allowed to stabilize at each temperature. During the cooling period, while still inside the chamber, the ties were then installed around the aluminum mandrels representing a small bundle diameter and a large bundle diameter. They were then inspected for any breakage or failure points.

Test 2 — Varying temperature tensile strength — high heat
Ten ties of each variety were fastened around mandrels and conditioned in a humidity- and temperature-controlled chamber at 125 °C (257 °F) in increments of 1,000 hours up to 5,000 hours. They were then reconditioned at 23 °C (73.4 °F) and 50% humidity — the smaller ties for 15 days and the larger ties for 30 days. They were then subjected to a split-mandrel tensile test and pulled to their rated loads for five minutes. If they held, the ties were then pulled to failure.

Test 3 — Extended UV exposure tensile strength
Groups of ties of each variety were fastened around mandrels and exposed to UV light in a controlled chamber for a total of 5,000 hours in 1,000-hour increments, with test samples beginning at 2,000 hours. Each group was then reconditioned at 23 °C (73.4 °F) and 50% humidity — the smaller ties for 15 days and the larger ties for 30 days. They were then subjected to a split-mandrel tensile test and pulled to their rated load for five minutes. If they held, the ties were then pulled to failure.

Test 4 — Vibration
Ten ties of each variety were conditioned at 23 °C (73.4 °F) and 50% humidity, then installed on horizontally and vertically mounted split mandrels and vibrated for 72 hours on an XY vibration table to test their ability to hold.

Test 1 — Low installation temperatures

The ability to install cable ties at low temperatures is crucial for installations that must withstand wide-ranging weather conditions, including those that operate outdoors, such as oil and gas facilities or rail, marine, ground or aerospace transportation, and those that operate indoors under a wide range of conditions, such as food and beverage plants.

We conditioned ties of each variety in a controlled chamber to several low temperature conditions, then checked their conditions after installation on a mandrel, if they survived installation at all.

Results
Ty-Rap metal barb cable ties performed with 100% success at the -20 °C, -40 °C, -50 °C and -60 °C (-4°F, -40 °F, -58 °F and -76 °F) levels. Most all-plastic ties experienced at least partial failure at such low temperatures. Some failed completely at all temperature levels tested.

Test 1 — Low installation temperatures

Minimum installation temperature — 50 lb. ties

	-20 °C	-40 °C	-50 °C	-60 °C
Ty-Rap				
Competitor 1				
Competitor 2				
Competitor 3				
Competitor 4				
Competitor 5				

Minimum installation temperature — 120 lb. ties

	-20 °C	-40 °C	-50 °C	-60 °C
Ty-Rap				
Competitor 1				
Competitor 2				
Competitor 3				
Competitor 4				

 Pass

 OK

 Fail

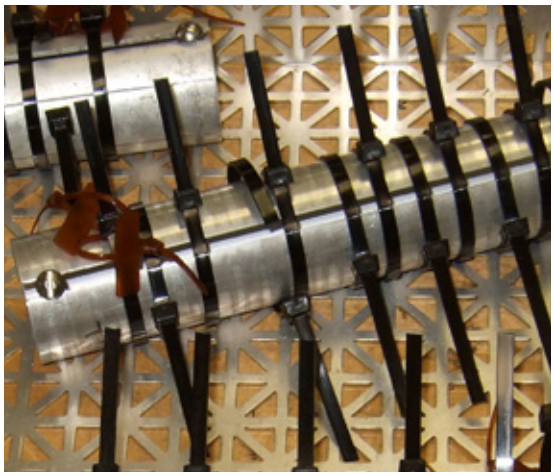
Test 2 — Varying temperature tensile strength — high heat

The ability to withstand constant high heat is crucial wherever such conditions are present, such as in engine compartments, various industrial settings and food and beverage facilities.

Results:
Ty-Rap metal barb ties exhibited superior tensile strength-to-failure characteristics under most high heat exposure conditions.

On the lower end of the performance scale, several all-plastic sample groups exhibited catastrophic failure while still in the heat aging chamber, prior to tensile testing.

The mode of failure is also important. Under most conditions, Ty-Rap metal barb ties simply slipped when they reached their failure point, resulting in no spread of debris. Many all-plastic ties snapped or shed their pawls, which could cause debris to fly into nearby products or applications.



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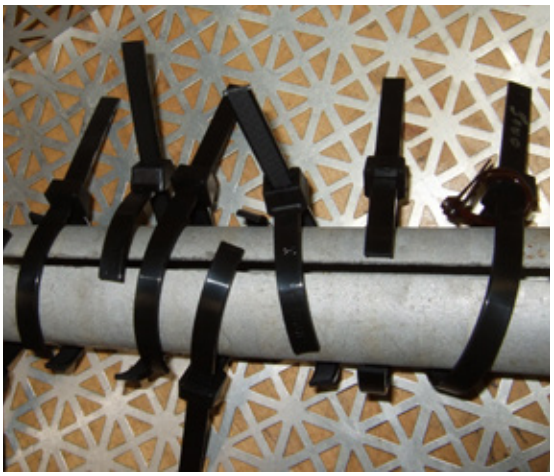
01 Competitors' ties breaking during 2,000 hr. heat aging



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02 Competitors' ties breaking during 4,000 hr. heat aging

Test 2 — Varying temperature tensile strength — high heat

125 °C heat aging — 50 lb. ties

	1000 hrs.	2000 hrs.	3000 hrs.	4000 hrs.	5000 hrs.
Ty-Rap					
Competitor 1					
Competitor 2					
Competitor 3					
Competitor 4					
Competitor 5					

125 °C heat aging — 120 lb. ties

	1000 hrs.	2000 hrs.	3000 hrs.	4000 hrs.	5000 hrs.
Ty-Rap					
Competitor 1					
Competitor 2					
Competitor 3					
Competitor 4					

 Pass

 OK

 Fail

Test 3 — Extended UV exposure tensile strength

The ability to withstand constant UV exposure is crucial in any industry that subjects equipment to extended outdoor exposure, including solar and wind equipment, oil and gas and all modes of transportation, including transportation facilities that require power such as road, bridge and rail signals and lighting.

Results:
Ty-Rap metal barb ties exhibited superior tensile strength-to-failure characteristics under most UV exposure conditions.

On the lower end of the performance scale, several all-plastic sample groups exhibited catastrophic breakage, although most were able to perform at least to their rated loads before failure ensued. Under all tested UV conditions, the Ty-Rap metal barb cable ties simply slipped when they reached their failure point, resulting in no spread of debris. Many all-plastic ties snapped or shed their pawls, which could cause debris to fly into nearby products or applications.

Test 3 — Extended UV exposure tensile strength

UV aging — 50 lb. ties

	2000 hrs.	3000 hrs.	4000 hrs.	5000 hrs.
Ty-Rap				
Competitor 1				
Competitor 2				
Competitor 3				
Competitor 4				
Competitor 5				

UV aging — 120 lb. ties

	2000 hrs.	3000 hrs.	4000 hrs.	5000 hrs.
Ty-Rap				
Competitor 1				
Competitor 2				
Competitor 3				
Competitor 4				

 Pass

 OK

 Fail

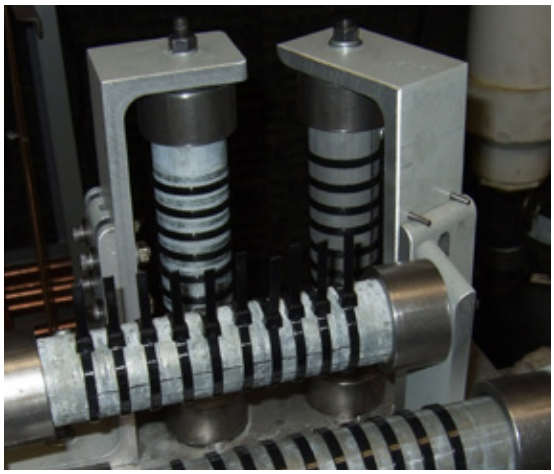
Test 4 — Vibration

The ability to withstand constant vibration is crucial in many industrial and transportation applications. Cable ties that slide out of place pose a hazard to properly holding the bundled wire.

Methodology
Ten ties of each variety were conditioned at 23 °C (73.4 °F) and 50% humidity, then installed on horizontally and vertically mounted split mandrels and vibrated for 72 hours on an XY vibration table.

Results
During the vibration process, Ty-Rap cable ties showed very little sliding/slippage on the test mandrel. The design of the ribs and stipples on the inside of the strap help prevent lateral slipping in applications while the adjustability of the smooth strap provides proper tension. While not all competitive cable ties failed this test, some showed significant slippage along the vertical vibration test.

Competitor 2 50 lb. ties showed significant slippage in vertical vibration, as shown below.



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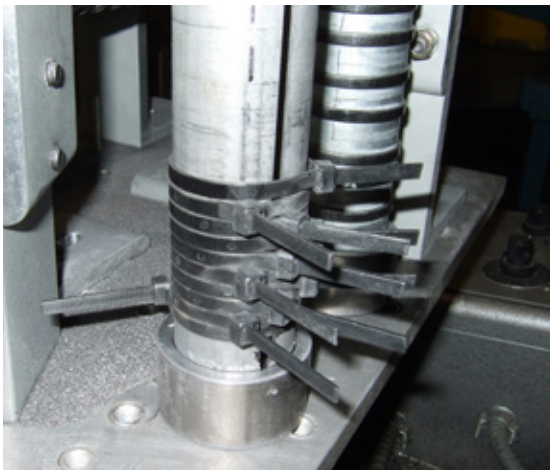

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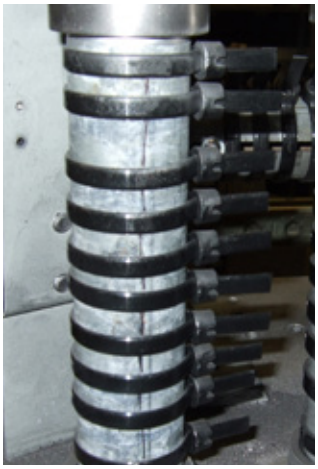

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04

—
01 Competitor 2
50 lb. ties before

—
02 Competitor 2
50 lb. ties after

—
03 TY27MX before

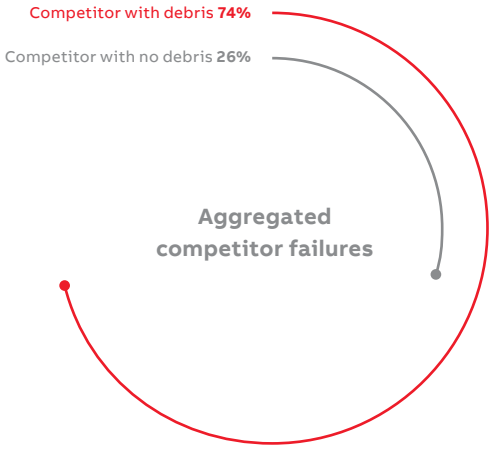
—
04 TY27MX after

Failure modes

— 01 Competitor failure modes
— 02 Ty-Rap failure modes

Also noted were the failure modes of all cable ties during testing. Ty-Rap cable ties generally fail without causing additional debris, or casting debris into the environment. All-plastic cable ties frequently have the ratcheting pawl fail, causing it to be ejected into the environment rather than staying captive in the tie head.

Graph 1 illustrates the percentage of competitor's all-plastic cable ties that failed causing debris to enter the nearby environment. Graph 2 shows that Ty-Rap cable ties rarely fail in a manner that causes debris.



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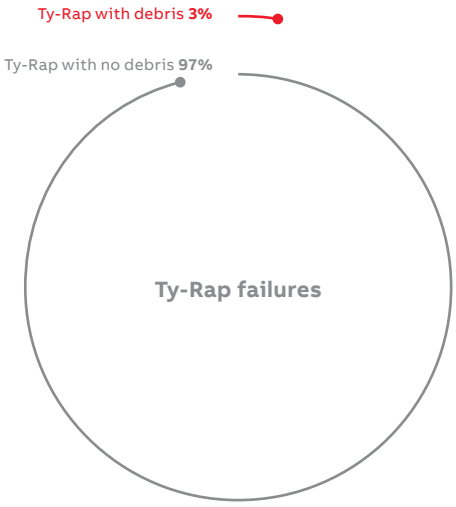

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Summary of test results

	Low temp. test	High heat test	Extended UV test	Vibration test	Debris on failure
Ty-Rap					
Competitor 1					
Competitor 2					
Competitor 3					
Competitor 4					
Competitor 5					

 Pass

 OK

 Fail

Note:
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7TKK000548 5.2019