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Classic Connectors, Inc.

Understanding the Mechanical Performance of ClampStar®

ClampStar® Design

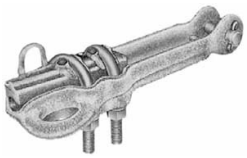
It is important to understand that the design of the ClampStar® Connector Correctors is similar to that of a side opening, inline deadend shoe, a long favored design, well proven to provide ample conductor tensile support, and widely used by nearly every electric utility.

A notable difference is that a comparable size ClampStar for a given conductor size will have more keepers, typically twice as many, and therefore, greater holding strength than a comparable size inline deadend! This fact alone should help anyone understand that the ClampStar units have sufficient clamping force to accommodate any normal tensions used in overhead conductor applications. The additional keepers are a portion of the electrical design, and assure that the integrity of the electrical connection of ClampStar units will be unsurpassed by any type of connector.

The typical side opening, inline deadend shoe, provides a clamped holding strength of 40-95% of the RBS of the conductor for which such devices are intended to be used, depending on the conductor type. The standard adopted by manufacturers has been ANSI C119.4 Class 2 Partial Tension for all bolted line hardware or strain clamps, and are tested to 40% RBS of the conductor.

The mechanical integrity of bolted line hardware is dependent upon the application as well as the conductor size and construction. This applies to all types of bolted conductor hardware, including straight line strain clamps, quadrant strain clamps, deadend shoes, etc. Like all bolted line hardware, ClampStar units have two mechanical strength ratings. One is the UTS or Ultimate Tensile Strength of the ClampStar body. ClampStar units have UTS ratings that well exceed the NESC maximum loading conditions of the largest conductor on which the ClampStar unit can be used.






Because bolted strain clamps and deadend shoes are range taking devices, accommodating several different types of conductors, such as ACSR, AAC, AAC, ACAR, etc., their ability to purchase a given conductor to a percentage of rated breaking strength, will vary with the conductor style and type. For example, a given deadend clamp, sized to hold a maximum conductor diameter of 1.108 inches may hold a 795 kcmil Lilac AAC, to 100% of its full RBS of 14,300 lbs., whereas the same 14,300 lbs. of tension would only be 45%, of the RBS of 795 kcmil Drake ACSR, rated at 31,500 lbs. applied in the same clamp. This meets the required and accepted standard, and they are used accordingly by virtually every utility in North America.

ClampStar® Testing

The intended application of ClampStar® is a "Connector Corrector" to be installed over a connector, or a damaged section of a conductor in normal tension. Thus, initially installed, there is no tension on the ClampStar, just as there is no tension imparted to trousers on a clothesline.

However, to provide the assurance that the ClampStar will provide the necessary electrical and mechanical integrity to an electrical conductor, they are tested without the benefit of a connector within their confines, having the test conductors simply terminated in each end.

ClampStar® Application

In its normal application, as a current shunt and a mechanical support for splices and other full tension connectors, as previously stated, there is no tension load on the ClampStar® unit because the connector over which the ClampStar is installed is holding the tension and the conductor span is already tensioned when the ClampStar unit is installed. Thus, the ClampStar / primary connector combination continues to maintain a full tension rating, dependent only on the condition of the present connector. If the application is over connectors known to be sound, for the purpose of allowing current/thermal uprating of the line, the ClampStar units will protect the connector, such that its temperature will never even approach the conductor temperature, and therefore, its mechanical integrity will never be compromised. As an example, connectors protected by ClampStar units will operate with less than a 30°C rise over ambient when conductor temperatures are 250°C rise over ambient.

Similarly, there is no tension load on the ClampStar unit when it is applied to shunt deadends, tangent suspensions, and other non-tension clamps and connectors.

Because of the positive engagement of the ClampStar with the conductor, there is no "wiggle room" as with other repair type devices. Helical type devices, commonly called "patch rods" loosely engage conductor strands, and allow them to slip slightly under varying degrees of tension. This allows a creep factor over time with such devices, allowing tension to vary on the original connector, and can result in it working out of the original connector. The positive engagement of ClampStar does not allow for this, operating exactly like a bolted deadend, such as an inline shoe type deadend or quadrant clamp.

The only purpose of ClampStar units having a tension rating is to assure that the ClampStar unit will continue to support the mechanical load and maintain conductor integrity in the unlikely event a severely degraded primary connector fails mechanically after ClampStar installation. For this to occur, the manner in which such failure would progress is that the conductor would begin to slip within the original connector, until the full tension is transferred to the ClampStar, which would typically be less than 1/8" of movement. This is not an instantaneous movement, but rather a slow transition due to the elastic properties of the conductor and components. As this progresses, a portion of the tensile load would be transferred to the ClampStar until such time that sufficient tension has been relieved and the slip is arrested. The best description may be an example:

Let us suppose we have a splice, rated for full tension, which is 95% of the conductor's rated breaking strength. For our example, we will use 795 Drake ACSR, having an RBS of 31,500 lbs. A full tension device would therefore be required to meet an ultimate tensile load of 29,925 (95% of RBS). Per NESC guidelines, the design is to provide that under maximum combined wind and ice loading, that the conductor shall not exceed 60% RBS, which in this case is 18,900 which is also the minimum design factor of the ClampStar. Let us assume a normal span having approximately 4500 lbs. tension. We know the connector is holding at least that much, or it would be on the ground, and we would not be placing a ClampStar on the line!

Let us now suppose an event has occurred, increasing the line tension to 15,000 lbs., and the original connector has started to slip. If the original connector would only hold 4600 (100 pounds more that the actual line tension, it does not simply let go with only 1/8" of slip, but will still hold most of that load – perhaps 4000 pounds. Therefore, the ClampStar will only be subjected to 11,000 pounds as its share of the load.

A more realistic scenario is that the original splice still had approximately 30% of its original design strength, (around 11,000 lbs.) as that is the degree of degradation of a fully annealed splice, and as the load increased to 15,000 lbs., approximately 4-5000 pounds would be transferred to the ClampStar, at which point the slip would be arrested in this example.
It is also useful to note that if that original connector was holding 4500 pounds, it was most likely doing it at an elevated temperature of sufficient magnitude to find it with an IR camera (the most common means of detecting deteriorated splices). Once it is protected by a ClampStar, its temperature will be much lower than that of the conductor itself, and therefore it will have a significantly higher tensile strength, typically on the order of 25% more.

The slip scenario just described, with load transfer to the ClampStar, applies only to CSF series ClampStar units because they are the only ones that may have sufficient slack between the clamping units to allow conductor slip to take place within the primary connector.

Given normal installation and clearance, CSR ClampStar units will not allow the slip to occur, as their opposed ends are "rigidly" fixed. In that case, mechanical failure of the primary connector could only occur if the conductor had been severely damaged within the primary connector prior to ClampStar installation and thermal runaway continued after installing ClampStar. The probability of that occurring is nil.

Conclusion

ClampStar® Connector Correctors meet or exceed the mechanical properties of bolted deadend shoes when properly installed. Bolted deadends have been employed in supporting the tensile load of conductors as long as conductors have been installed in overhead applications – over 100 years!

As previously stated, bolted line hardware is dependent upon the application. The conductor holding or slip strength is dependent upon the conductor used. ClampStar Connector Correctors alone are designed and tested to hold at least 60% RBS of the largest and highest strength non-homogenous conductor (typically ACSR) for which it is designed, without the benefit of any connector within the ClampStar unit. However, in most applications, the ClampStar units slip strength will exceed that rating and most AAC conductors will be held to at least 95% of the conductor RBS, which is considered to be full tension.

As a general statement, ClampStar Connector Correctors, will restore aged connectors to their original mechanical performance ratings, and exceed the original electrical ratings, allowing system uprating to conductor operation of 250C. Please let us know if there are any questions or if you require additional information or assistance.