Inter-vehicle systems

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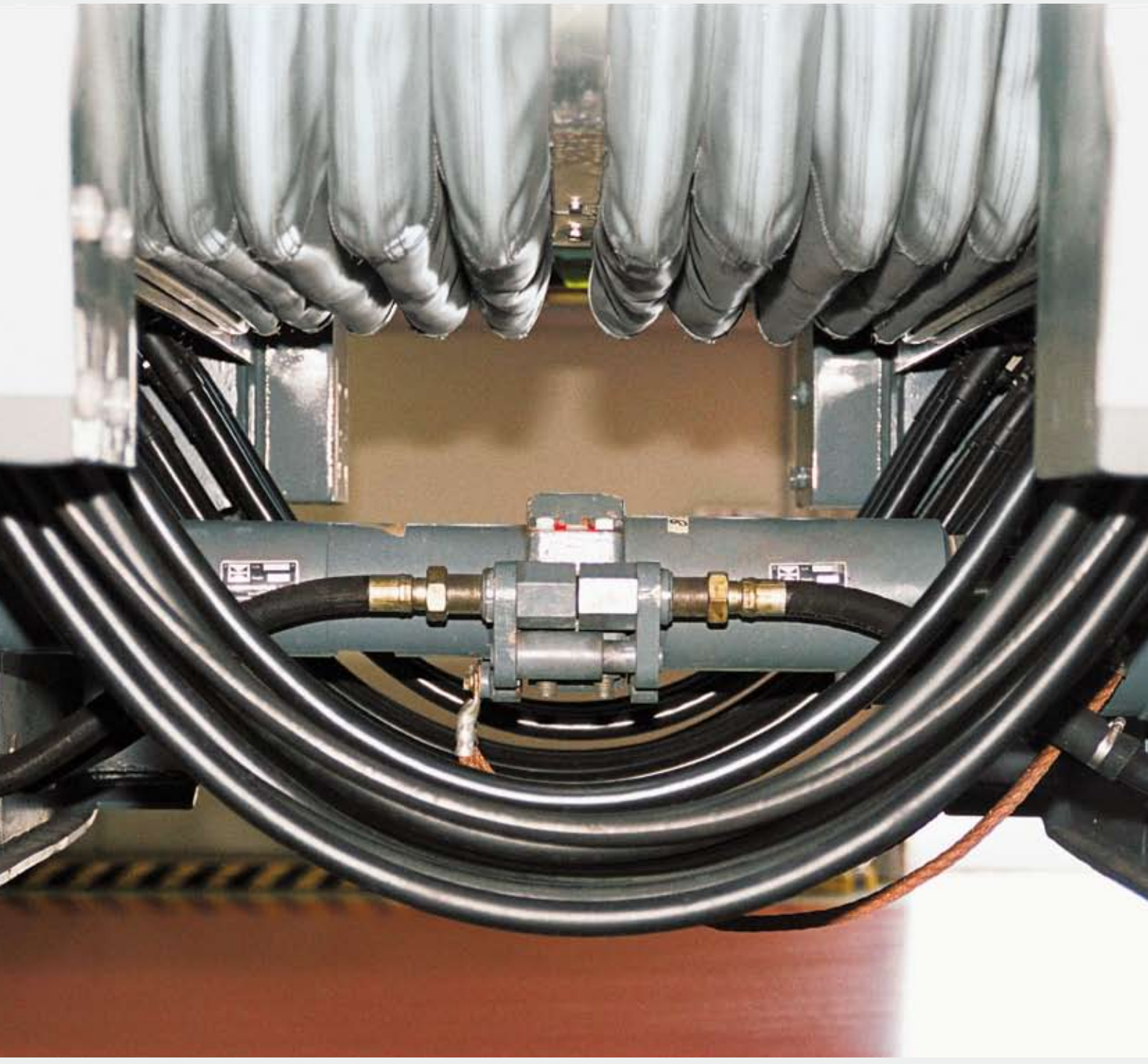

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HUBER+SUHNER carriage transition solution

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Inter-vehicle systems

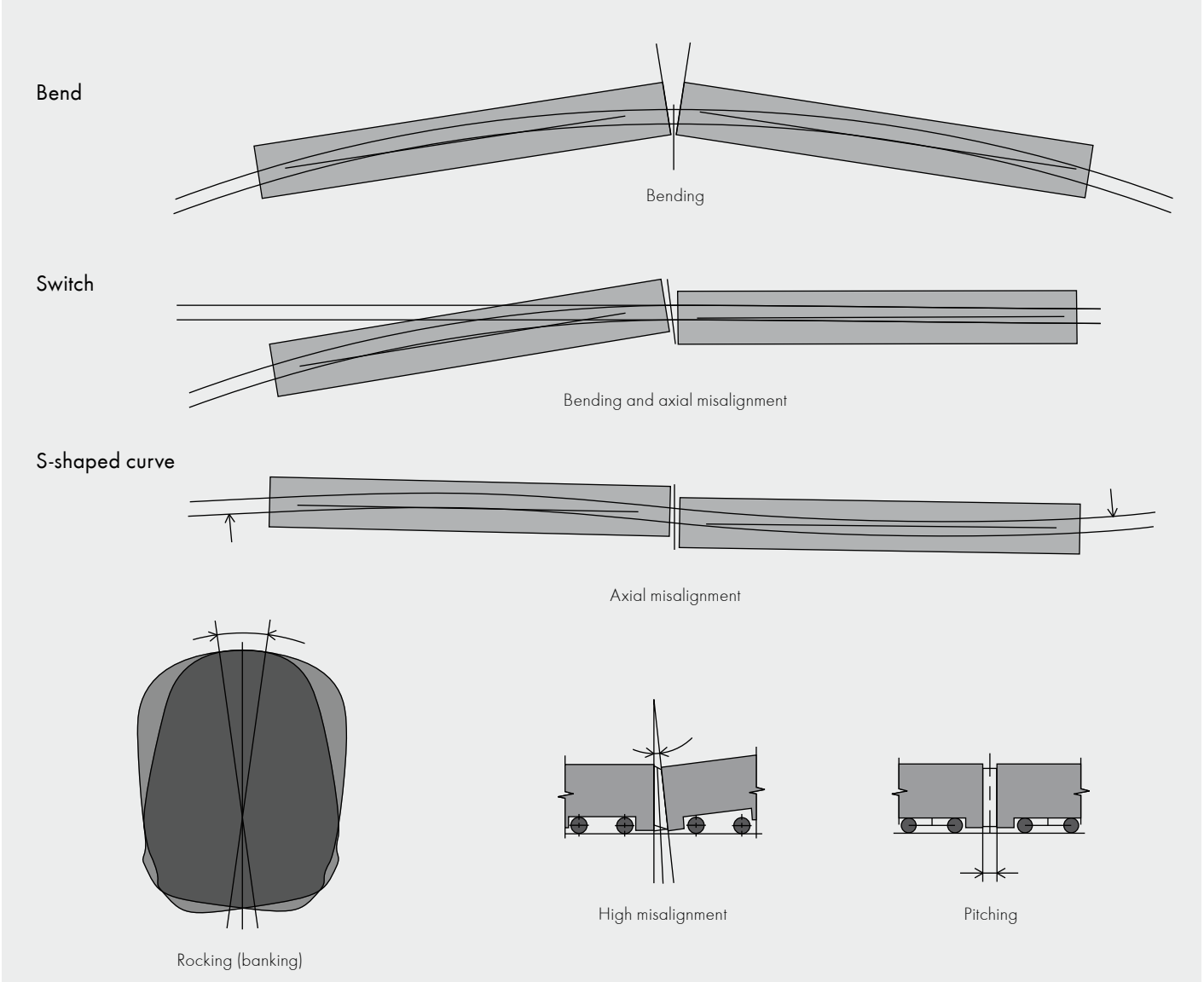
Relative motion between the carriages

Inter-vehicle systems contain the individual supply cables and are used between two coupled carriages or between the traction vehicle and carriages. These systems, in which the supply cables run across the coupling point, must withstand high stresses. The supply cables are made up of power cables for transmitting different voltages and of signal and data lines. In order to ensure a reliable, safe and durable cable connection, inter-vehicle systems must be tailored to the specific requirements. .

Inter-vehicle systems and the supply cables they contain are exposed to numerous different types of motion caused by bending, axial misalignment, rocking, pitching, longitudinal motion and height misalignment.

Bending refers to the horizontal deflection of the carriages as they pass through bends. The smaller the radius of the curve, the greater the bending action. Axial misalignment is the deflection crosswise to the direction of travel when a train passes through an S-shaped bend, for example over a switch. This motion exposes the cables to torsion. Rocking describes the rotation around the longitudinal axis of the train, and pitching the vertical deflections when the train passes over a hill or across the trough of a valley. The term longitudinal motion refers to the inward and outward spring deflections of the coupling and height misalignment to the differences in spring deflection between two carriages.

The critical design factors are bending and axial misalignment. But a suitable design must also give consideration to the other relative motions. The motions are also influenced by the specific carriage design. This concerns especially the extent of the carriage deflections.



Influencing factor

The main influencing factors are the rolling stock design and the track profile. In the rolling stock design, the horizontal position at the face of the carriage and the distance from the face to the bogie pivoting point will influence the extent of the cable motions. The larger the distance, the wider these motions will occur. In connection with the track profile, the important factors are the track radius and the geometry of the switch transition. Tighter rail radii will produce larger cable motions.

In order to avoid collisions with other components, sufficient clearance must be provided in arranging the cables. If installation space conditions are tight, it is advisable to conduct a fitness test on the prototype. This will allow, for example, the optimal cable length to be determined.

Stressing

The above-mentioned relative motions and influencing factors essentially determine the stresses acting upon the cable. They expose inter-vehicle systems to extreme stresses, which have a direct impact on the cable life cycle. Continuous stressing is produced by a number of factors, some of which intensify each other. The main stresses are bending, torsion and vibration. But stresses acting upon these cables also include tension, compression, thrust, impact, abrasion, rupturing, deformation and crushing. In addition to these dynamic mechanical stresses, environmental influences also stress cables, for example temperature, humidity and moisture, sunlight, precipitation (rain, snow, hail), icing etc. Also the position of installation of the cables influences overall stressing. All of these factors determine the service life of inter-vehicle systems.

Following is a description of the individual stress factors. The temperatures to which cables are exposed during service may vary widely, ranging from -40°C to 120°C, depending on the current loading and the ambient temperature. Stresses are especially high in combination with bending and torsion. The service life is determined by the design of the cable, the elements, their interactions and the materials used, but also by the suspension and routing of the cables. The life expectancy can be determined by quick-motion tests. HUBER+SUHNER tests the cables under the most realistic installation conditions possible, and this under precisely defined failure criteria. The tests are based on the number and extent of the motion cycles expected during the planned service life of the cables.

Design of the cables

The suspension and routing of inter-vehicle cables essentially determines their useful life and thus their cost efficiency. The individual components are stranded to suit the specific application. Stranding has a positive effect on the bending characteristics, flexibility and stability of the cable. In order to reduce the torsional stresses acting upon the cable elements, special design measures are taken to optimise performance. A compact design provides better protection of the individual cable elements inside the cable against vibration and acceleration than a loose design with corrugated tubes.

Requirement profile for cable jackets

The cable jacket must satisfy extreme requirements in order to protect the inside of the cable against the multitude of different outside influences. The requirements to be fulfilled include flexural fatigue strength and elasticity also at low temperatures as well as resistance to chemicals, impact and ultraviolet radiation. Special attention must be paid to resistance against corrosive acid- or alkali-based cleaning agents. Additional external influencing factors include dust, friction, oils, greases, falling rocks, cuts, sparks and fire. The requirements that a high-grade cable jacket must fulfil also include favourable processing properties. They will allow cost-effective production to be achieved and thus competitive solutions to be developed.

Design of the connectors and anti-buckling sleeve

Anti-buckling sleeves

The advantage of using anti-buckling sleeves is obvious. As the cable elements are "carried" by the cable jacket, the sleeve and the union, they are not loaded by their dead weight. In addition, anti-buckling sleeves eliminate the problem of cable element pinching at clamping points associated with unions.

HUBER+SUHNER surrounds the cable with an injection-moulded anti-buckling sleeve, which produces a permanent connection with the cable jacket. This design ensures that the torsional forces acting on the cable are permanently transmitted to the cable gland (connectors and sleeves). In addition, no clamping forces will act upon the cable elements. However, this effectively prevents the buckling of the cable during bending.

UNI-DICHT-system

The selective clamping steps of the UNI-DICHT system ensure optimal transmission of the clamping force to the individual components inside. Distribution of the pressure across a wide surface area protects them against damage. In addition, sealing to IP68 and tension relief are ensured. Furthermore, the UNI-DICHT inserts are provided with a membrane allowing an IP54 enclosure even when the union is not tightened.

Commercially available clamping unions

There are differences with clamping unions and other tension-relieved systems. Manufacturers will not grant any warranties for such designs. Users themselves must verify whether clamping unions and similar designs are suitable for their specific applications. Owing to the clamping of the union, the cable elements are self-supporting. But constant clamping inside the union reduces the life expectancy dramatically. In addition, torsion will eventually damage the

clamped connection between the seal and the jacket. The same is true for the torsion acting on the seal – the original enclosure standard will be maintained only briefly. Another negative effect is produced by buckling in the clamping area as a result of bending. Lastly, the differences in length of non-stranded, merely twisted elements will substantially increase sensitivity to bending. And since clamping unions and other tension-relieved systems do not take vibration into account, this deficiency will also lead to major drawbacks – which can be avoided in the first place by selecting the most suitable cable.

Comparison between inter-vehicle systems with and without HUBER+SUHNER anti-buckling sleeve

In the system cables that HUBER+SUHNER produce, tension relief is achieved from the cable jacket via the anti-buckling sleeve to the union. This design produces a uniform, parabolic transition profile from the cable in motion to the rigid union. The sleeve diameters and lengths are selected to suit the specific installation conditions. Another advantage is that the entire cable entry, the cable, the sleeve and the union are prevented from rotating. These elements are also dust- and water-tight.

Another very valuable feature is the greatly increased service life of the tension relief device, which runs through the sleeve: It is ten to twenty times higher than without a sleeve.

HUBER+SUHNER inter-vehicle cables with protective sleeves offer clear and reproducible installation conditions without radial integration of the inner cable design. Thanks to their small diameters, they are also excellently suited to very tight installation space conditions. Another benefit is that the life expectancy of the unions is predictable. The approximation is obtained through dynamic long-term testing.

The solutions from various manufacturers of inter-vehicle systems using corrugated tubes and unions offer the advantage of easy assembly. Their drawback, however, is that the action of the unions mounted at the two ends on the cable is undefined, which drastically reduces their life cycle. However, their large dimensions take up more space, as the cross-section of the corrugated tube can only be utilised to a certain extent. In addition, water will enter the corrugated tubes in the event of sealing problems and might freeze at sub-zero temperatures. This may restrict the freedom of motion of the elements inside the corrugated tube and lead to line ruptures and thus to a cable failure.

The retrofitting of additional cores is only possible to a certain extent, i.e. only by cable modification if this is allowed at all by the inner cable configuration. With the corrugated tube variant, retrofitting of additional cores is readily possible, but the filling degree may be a limiting factor.

User-defined inter-vehicle systems

Based on its wide product portfolio, HUBER+SUHNER is in a position to supply exactly the right cable for meeting specific customer needs. This means that HUBER+SUHNER applies its proprietary RADOX "JUMPER" railway cable in designing inter-vehicle systems. These jumper cables are available as hybrid cables incorporating coaxial or fibre optic elements. Based on a customer's specific requirements, jumper cable assemblies are manufactured with plastic-coated anti-buckling sleeves and – if necessary – with a special preformed "Hair Pin" (H+S patent). These are thermally preformed inter-vehicle lines for small distances between carriages.

Last but not least, user-friendliness during service is another important feature that must be taken into account when selecting an inter-vehicle system. Ease of handling includes high bending and torsion capabilities, low weight, the capability to operate effectively under different conditions and a space-saving design. The performance catalogue is rounded off by a predictable life cycle, documented safety of the future standard EN 45545-2 and physical characteristics which are described in the relevant H+S data sheets.

Conclusion

Inter-vehicle systems must satisfy stringent demands, since the cables in motion are subjected to a wide range of different mechanical stresses. These are caused especially by vibration, bending and torsion in addition to occasionally extreme operating conditions and environmental influences. System cables are manufactured on the basis of specific customer needs, taking into account the proven HUBER+SUHNER design guidelines. Manufacturing is fairly time-consuming because the cables pass through several in-line process operations. The earlier HUBER+SUHNER is familiarised with concrete projects, the easier it will be to satisfy the relevant customer needs. As a system provider, HUBER+SUHNER offers professional consulting as early as during the development phase. In order to produce optimal cable design solutions, it makes sense in the project engineering phase to allow the widest possible latitude in terms of how the cores and elements are to be combined in the cables.

About HUBER+SUHNER

HUBER+SUHNER is a leading international producer and provider of electrical and optical interconnectivity components and systems. The industrial group headquartered in Switzerland was established in 1969 and is represented today by 17 subsidiaries and 3200 employees in all the global markets and by over 100 distributors in additional countries. HUBER+SUHNER unites core competencies in low-frequency, radio-frequency and fiber optic technology under a single roof and offers a range of high-grade products for its main markets – communications, transport and industry.

RailwayCableSystems. Wherever you are.

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