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Application of injection screws in the repair of dynamically loaded steel structures | AiF No.: 21369N

Summary of the research project AiF No.: 21369N

Injection screws provide a slip-free shear-resistant bolted connection by filling the existing hole clearance with hardening injection resin. Neither time-consuming reaming of the drill holes as with connections using precision-fit bolts, nor extensive surface treatment as with slip-resistant preloaded connections is required. The injection resin is injected through a hole in the screw head into the area between the screw shaft and the hole wall. For this purpose, specially machined screw sets are required, which are specified in DIN EN 1090-2, Annex J. The design of non-prestressed and prestressed designs is already included in DIN EN 1993-1-8; information on the fatigue strength of the connection is also provided in the fatigue classification tables in DIN EN 1993-1-9. Despite existing regulations for the design and dimensioning of connections with injection screws, these are classified as a special fastener according to DIN EN 1090-2. In the case of application, qualification tests must therefore be defined and carried out, which currently severely limits user-friendliness. Despite the advantages of injection screws over other slip-free connections, this type of connection has not yet been able to establish itself in Germany.

Previously, there have been no clear criteria for selecting suitable injection resins. Therefore, relevant material properties of resin systems were investigated and required dimensions were determined. Sub-sequently, the hole bearing strength was determined according to DIN EN 1090-2, Annex G as the decisive design value for different injection resins. In addition, the design specifications according to DIN EN 1993-1-8 for prestressed connections were reviewed. Extensive test data for the addition of the load-bearing components due to the sliding resistance and the bearing resistance of the injection resin are not yet available. The interaction of the load-bearing components was investigated on different injection resins and surfaces, and the design specifications could be confirmed for the investigated connections. The findings on load-deformation behavior were also supplemented with numerical investigations.

No test data were available for the fatigue strength of connections with injection screws in DIN EN 1993-1-9. Therefore, fatigue tests

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were carried out with different injection resins on both non-prestressed and prestressed joints. The fatigue classification specifications were confirmed for all resin types. Since DIN EN 1993-1-9 does not contain any information on the fatigue strength of the injection resin, the fatigue-slip behavior of the injected joints was investigated. It was shown that no material fatigue of the resins takes place. Instead, creep effects must be taken into account and the maximum bearing stresses must therefore be limited. The corresponding limit values were defined for the non-prestressed and prestressed versions.

To ensure safe use of injection screws even under environmental influences, different hardening and storage conditions were investigated. For the selected resin systems, no significant influence on the load-deformation behavior of the connections could be determined, which is why connections with injection screws can be injected even at low temperatures and under traffic, as well as used in bridge construction subject to extreme temperature loads. Any restrictions must be included in detailed execution instructions in order to ensure the required quality of execution of the connection in addition to practical handling.

Overall, the basis for standardized applicability of injection screws has been created. The influencing factors investigated enable safe use in steel structures subject to dynamic stress. Suitable injection resins were identified and required material parameters were determined. In addition, extensive information on design and execution is available in the form of a developed design and execution concept.

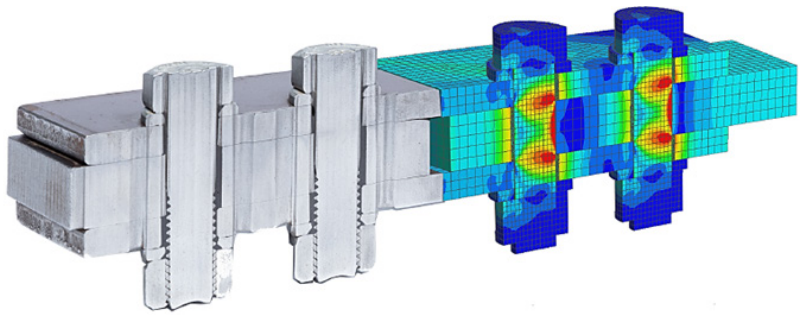

Image 1: Section through a standard specimen with injection screws in the experimental and nu-merical consideration

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