

TECHNICAL REPORT  
RAPPORT TECHNIQUE  
TECHNISCHER BERICHT

CEN ISO/TR 20491

December 2021

ICS 21.060.01

English Version

Fasteners - Fundamentals of hydrogen embrittlement in  
steel fasteners (ISO/TR 20491:2019)

Fixations - Principes de la fragilisation par l'hydrogène  
pour les fixations en acier (ISO/TR 20491:2019)

Mechanische Verbindungséléments - Grundlagen der  
Wasserstoffversprödung in Verbindungséléments aus  
Stahl (ISO/TR 20491:2019)

This Technical Report was approved by CEN on 29 November 2021. It has been drawn up by the Technical Committee CEN/TC 185.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

## Contents

	Page
European foreword.....	3

## European foreword

The text of ISO/TR 20491:2019 has been prepared by Technical Committee ISO/TC 2 "Fasteners" of the International Organization for Standardization (ISO) and has been taken over as CEN ISO/TR 20491:2021 by Technical Committee CEN/TC 185 "Fasteners" the secretariat of which is held by BSI.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

## Endorsement notice

The text of ISO/TR 20491:2019 has been approved by CEN as CEN ISO/TR 20491:2021 without any modification.

# TECHNICAL REPORT

ISO/TR  
20491

First edition  
2019-02

---

---

---

## Fasteners — Fundamentals of hydrogen embrittlement in steel fasteners

*Fixations — Principes de la fragilisation par l'hydrogène pour les  
fixations en acier*





## **COPYRIGHT PROTECTED DOCUMENT**

© ISO 2019

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

	Page
<b>Foreword</b>	<b>iv</b>
<b>Introduction</b>	<b>v</b>
<b>1 Scope</b>	<b>1</b>
<b>2 Normative references</b>	<b>1</b>
<b>3 Terms and definitions</b>	<b>1</b>
<b>4 Symbols and abbreviated terms</b>	<b>4</b>
<b>5 General description of hydrogen embrittlement</b>	<b>4</b>
<b>6 Hydrogen damage mechanism</b>	<b>4</b>
<b>7 Fracture morphology</b>	<b>5</b>
<b>8 Conditions at the tip of a crack</b>	<b>7</b>
<b>9 Conditions for hydrogen embrittlement failure</b>	<b>7</b>
9.1 Root cause and triggers for hydrogen embrittlement failure	7
9.2 Material susceptibility	8
9.2.1 General	8
9.2.2 Defects and other conditions causing abnormal material susceptibility	10
9.2.3 Methodology for measuring HE threshold stress	10
9.3 Tensile stress	11
9.4 Atomic hydrogen	12
9.4.1 Sources of hydrogen	12
9.4.2 Internal hydrogen	12
9.4.3 Environmental hydrogen	13
<b>10 Case-hardened fasteners</b>	<b>13</b>
<b>11 Hot dip galvanizing and thermal up-quenching</b>	<b>15</b>
<b>12 Stress relief prior to electroplating</b>	<b>16</b>
<b>13 Fasteners thread rolled after heat treatment</b>	<b>16</b>
<b>14 Hydrogen embrittlement test methods</b>	<b>17</b>
<b>15 Baking</b>	<b>17</b>
<b>Bibliography</b>	<b>19</b>