



ZF Friedrichshafen AG · 94030 Passau

Commercial Vehicle Technology
Axle and Transmission Systems for Buses and
Coaches

Potential quality defect in the wheel bearing assembly of ZF axles of the type A/AV/AVN

Dear Sir/Madam,

To our regret we have to inform you today about a possible defect in the wheel bearing assembly of ZF axles of the type A/AV/AVN from the production period of January 2016 to March 2017.

Description of the defect

Within an evaluation of screwing data of the wheel bearing assembly in October 2016 a high variation of the screwing angles of the slotted nuts has been detected. Because of this an intense root cause analysis and elimination process has been started. The investigations revealed that on some axles a settlement in the bearing assembly had occurred which could result in a loss of tightening torques of the threaded connections during operation and also a damage to the locking plate. This has also been verified by checks on axles in the field which had been selected by suspect screwing angles.

Cause

According to the current state of knowledge settling phenomena within the wheel head assembly are responsible for the reduced tightening torques. These were caused by the increased surface roughness of the bearing seats in the hub after a change in the machining process. Axles which have been produced in the period between January 2016 and March 2017 may be affected.

Chairman of the Supervisory Board: Prof. Dr. Giorgio Behr
Board of Management: Dr. Stefan Sommer (CEO), Dr. Konstantin Sauer,
Jürgen Holeksa, Michael Hankel, Wilhelm Rehm, Dr. Franz Kleiner, Peter Lake
Headquarters: Friedrichshafen ·
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Scope and time period

- Analysis and evaluation of the assembly data of the screwdriver station regarding torque and rotation angle show variations correlating with the above mentioned causes. The occurrence of possible defects can be limited to the period from 01/2016 to 03/2017.
- Deviations can be seen in increased rotation angles to reach the nominal torque at the inner slotted nut.
- The connection between possible settling phenomena and the rotation angle of the inner slotted nut has been verified in field tests and compared with the corresponding assembly data.
- The results showed that only part of the axles produced with a rotation angle of minimum 35° at the inner slotted nut is potentially affected.

Risk assessment

- Based on the detailed analysis of available data from the assembly line and field inspections, this issue is not safety relevant.

The following corrective measures should be carried out with the vehicles concerned:

- Disassembly of the wheel head threaded connection, replacement of locking plate and re-assembly of the wheel head threaded connection. Details see ZF service bulletin 80-17 (attached to this letter/email).
- The corrective measures shall be conducted during the next regular service interval within the next 6 months or 40.000 km (whatever comes first).

ZF provides the following information

- List of potentially affected axles
- Service bulletin containing instructions for recommended rework

ZF requires the following information

- List of vehicles with potentially affected axles in the field including data as to owner/location/country/first registration/type of vehicle
- Contact person in your company to coordinate the next steps

Further action

- Coordination of resources and responsibilities for carrying out the measures recommended in the field between your company and ZF.
- Please contact us regarding possible notification requirements to public authorities.

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ZF contact for the coordination of the inspection campaign:

Name: ZF North America, Schelkle Frank
Phone: +1 770 297 4119
E-mail: Frank.Schelkle@zf.com

ZF contact person for potential reporting obligations to public authorities:

Name: Andreas Löffler
Phone: +49 7541 77-4832
E-mail: andreas.loeffler@zf.com

Please excuse any inconveniences and time requirements in your company caused by this quality issue.

Our team will be available to answer any further questions in a personal meeting or in a conference call.

Thank you for your understanding and cooperation.

Sincerely,



i.V. Dr. Andreas Grossl



i.V. Christian Klemm

Attachments:

1. Presentation with further details on the issue
2. List of potentially affected axles
3. Service bulletin containing instructions for recommended rework

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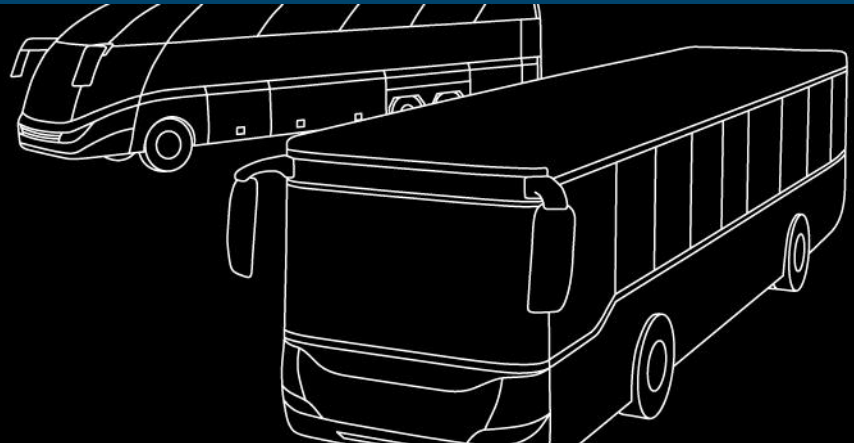
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ZF Quality issue

Wheel bearing assembly

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ZF Quality issue - wheel bearing assembly

Problem description:

- The wheel heads of the rear axles A/AVN/AV are locked by a system of two slotted nuts and a tab washer. The inner slotted nut is tightened with 850 Nm and the outer nut with 1200 Nm. The tab washer between both nuts is used as locking device additionally to the countering of the two nuts
- Within an evaluation of screwing data of the wheel bearing assembly in October 2016 a high variation of the screwing angles of the slotted nuts has been detected. Because of this an intense root cause analysis and elimination process has been started.
- The investigations revealed that on some axles a settlement in the bearing assembly had occurred which could result in a loss of tightening torques of the threaded connections during operation and also a damage to the locking plate. This has also been verified by checks on axles in the field which had been selected by suspect screwing angles.

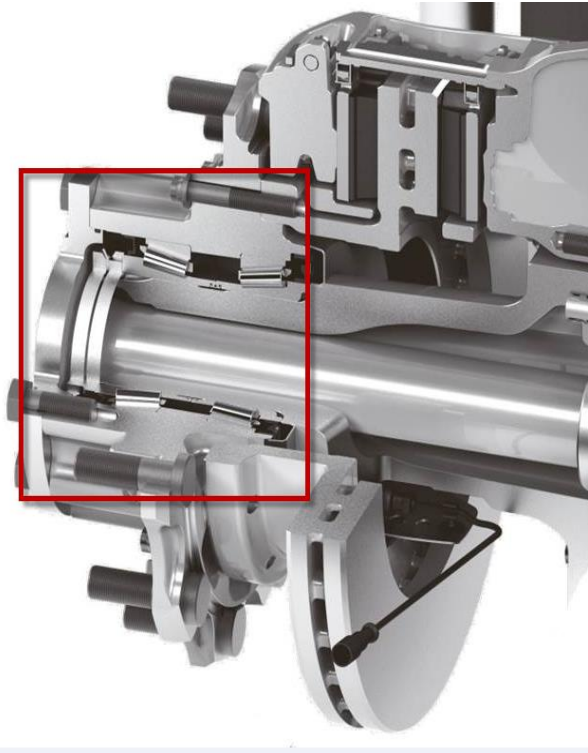
Root cause:

- Hubs were delivered with a surface roughness of bearing seat of wheel bearing at upper level of tolerance, starting at beginning of 2016 until March 2017.

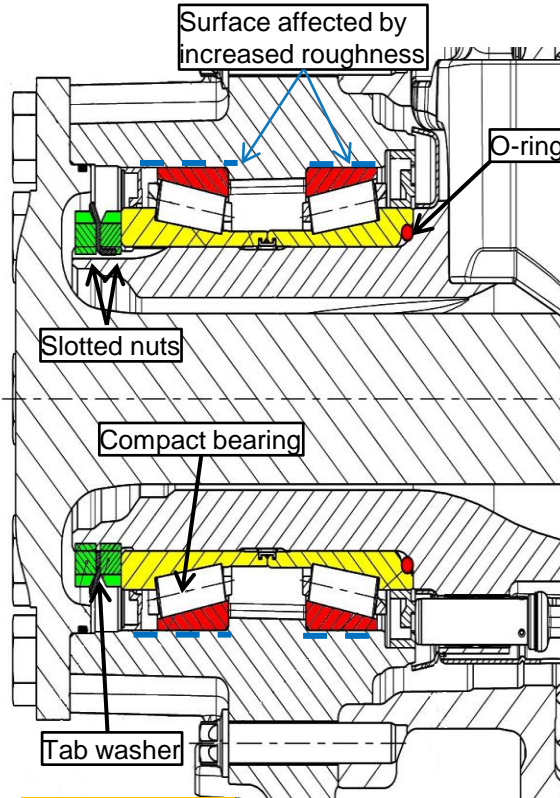
Risk assessment:

- Based on the detailed analysis of available data from the assembly line and field inspections, this issue is not safety relevant.

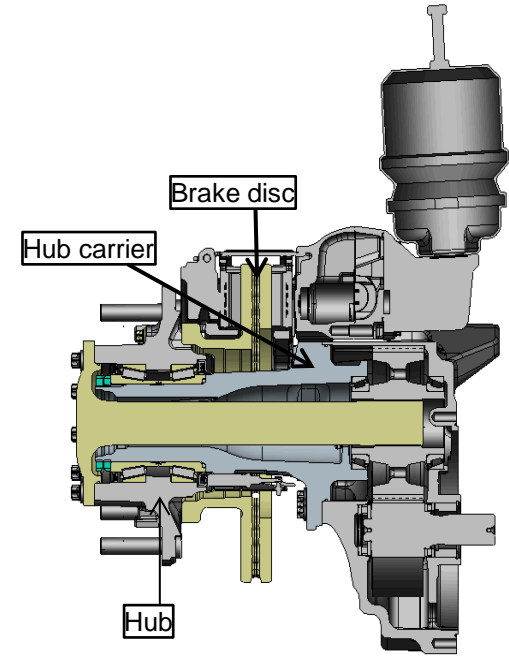
ZF Quality issue - wheel bearing assembly



Sectional view wheel head



Wheel head components



Wheel head components

ZF Quality issue - wheel bearing assembly

Containment Actions:

- 100% manual recheck of every axle if the torque is OK
- Investigation of the issue in a UFB-team
- Improvement of screwing parameter (reduced speed, multilevel screwing process)
- Definition of limitations of the screwing angle

Corrective actions:

- Change back of machining process of hubs → end of affected period

Dates Implemented:

- October, 2016
- October, 2016
- January, 2017
- May, 2017

Dates Implemented:

- March, 2017

ZF Quality issue - wheel bearing assembly

Mode of verification and result:

- Analysis of assembly data (torques and angles of wheel bearing assembly) after implementation of containment and corrective actions showed a significant stabilization of process (less variation of angles)
- Axles built after March 2017 have been checked and showed no deviations

Potentially affected axles:

- Axles with a screwing angle of inner slotted nut $>35^\circ$ produced between January 2016 and March 2017
- Detailed list with potentially affected axle serial numbers will be provided for each affected OEM

Remedy for potentially affected axles in the field:

- Disassembly of the wheel head threaded connection (slotted nuts), replacement of locking plate and re-assembly of the slotted nuts. Details see ZF service bulletin 80-17.

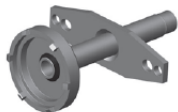


Necessary special tools and spare parts

Necessary special tools:

A132 / AV132II / AVN132 / AV133:

- 5870.401.146 Slotted nut wrench



5870.401.146

Slotted nut wrench

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AV110:

- 5870.401.136 Slotted nut wrench
- AA02.040.033 Centering plate



5870.401.136

Slotted nut wrench



AA02.040.033

Centering plate

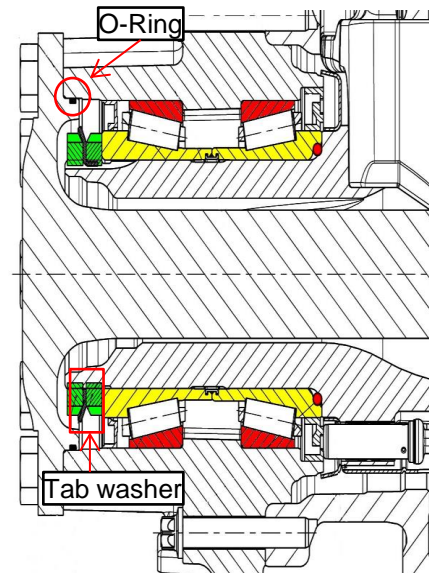
Necessary spare parts:

A132 / AV132II / AVN132 / AV133:

- O-Ring 0634.303.940 (2 pcs per axle)
- Tab washer 4474.335.144 (2 pcs per axle)

AV110:

- O-Ring 0634.306.309 (2 pcs per axle)
- Tab washer 4474.375.111 (2 pcs per axle)



Information regarding cost coverage

Labour covered for check and rework:

| | |
|---------------------------------|-----------------|
| A132 / AV132II / AV133 / AV110: | 2,00 hrs / axle |
| AVN132: | 1,00 hrs / axle |

Labour covered for other necessary work:

| | |
|----------------------------------|--------------------|
| Preparation, documentation etc.: | 1,00 hrs / vehicle |
|----------------------------------|--------------------|

Spare parts covered for this campaign:

See slide 6

This campaign shall be finished technically and commercially latest by end of 2018.



Thank you





Checking of slotted nut-hub bolt connection on A 132, AV 110/132/133, AVN 132

For quality assurance purposes the slotted nut bolt connection of the hubs must be checked on selected serial numbers of bus axles of the type A 132, AV 110/132/133 and AVN 132 produced in the period from January 2016 to March 2017. For implementation, the responsible Service Partners will be informed about the location of the actually affected axles by the Technical Customer Service of ZF or by the vehicle manufacturer.

The necessary work steps are indicated on the following pages.

| Contents | Page |
|--|------|
| ▪ Checking of slotted nut-hub bolt connection on A 132, AV 110/132/133 | 2 |
| ▪ Checking of slotted nut-hub bolt connection on AVN 132 | 5 |



Checking of slotted nut-hub bolt connection on A 132, AV 110/132/133

Safety instructions environment

Operating supplies and auxiliary materials may not be allowed to enter the soil, groundwater, or sewage system.

- Request material safety data sheets for the corresponding ZF products from your responsible environmental protection authority, and observe them.
- Collect operating supplies and auxiliary materials in a sufficiently large container.
- Dispose of operating supplies and auxiliary materials, waste, containers, soaked cleaning cloths, contaminated filters, etc. in accordance with the regulations of the environmental protection laws.
- Pay attention to the manufacturer's regulations and accident prevention regulations.

When selecting operating supplies and auxiliary materials, pay attention to health risks, environmental compatibility, disposal regulations and your country-specific opportunities to dispose of such materials properly.

For further safety instructions refer to the corresponding Repair Manual.

Requirements:

- Vehicle jacked-up.
- Wheels may remain on the vehicle.

Special tools:

- 5870.401.146 Slotted nut wrench

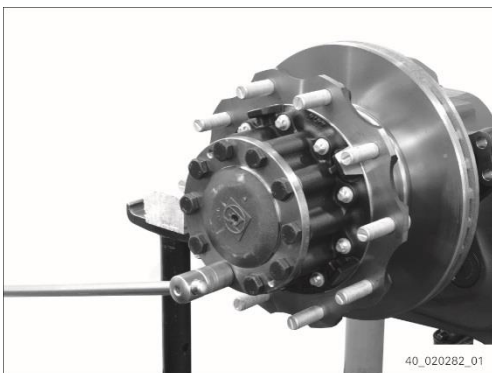


Figure 1

1. Fix hub by inserting the parking brake.
2. Loosen screws of the flange shaft.



Figure 2

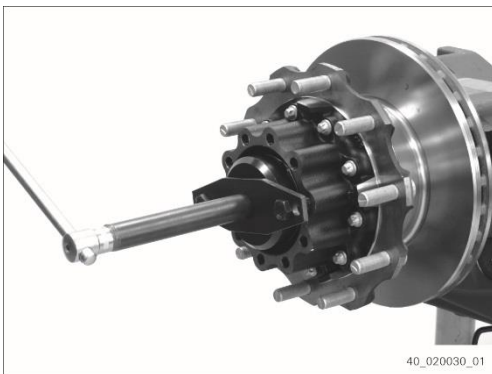


Figure 3

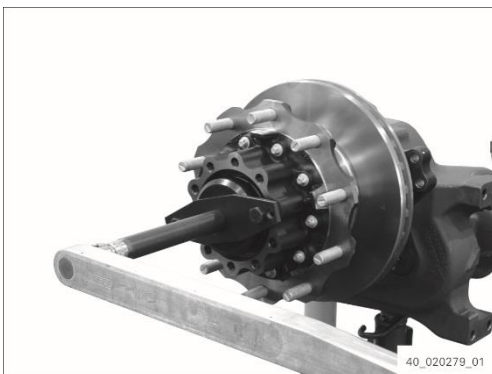


Figure 4

3. Observe safety instructions environment.
Remove flange shaft and collect leaking oil.
4. Unlock outer slotted nut.
5. Loosen outer slotted nut with 5870.401.146 [slotted nut wrench].
6. Remove locking plate.
7. Loosen inner slotted nut with 5870.401.146 [slotted nut wrench].
8. Tighten inner slotted nut with 5870.401.146 [slotted nut wrench].
Tightening torque: **100 Nm**
9. Rotate the hub in both directions several times.
10. Tighten inner slotted nut with 5870.401.146 [slotted nut wrench].
Tightening torque: **850 Nm**
11. Push **new** locking plate with tab pointing inwards onto the hub carrier.
12. Bolt on outer slotted nut with the chamfer pointing inwards.
13. Tighten outer slotted nut with 5870.401.146 [slotted nut wrench].
Tightening torque: **1200 Nm**

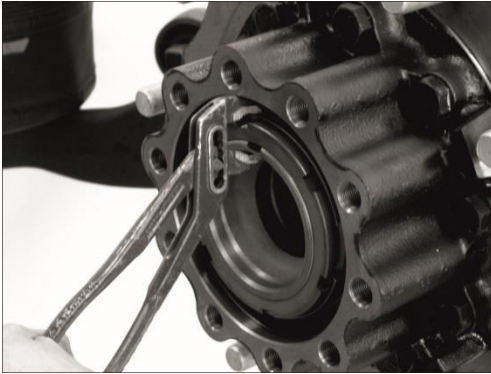


Figure 5

14. Secure outer slotted nut with locking plate.



Figure 6

15. Grease **new** O-ring (1) and insert it into the annular groove of the flange shaft.

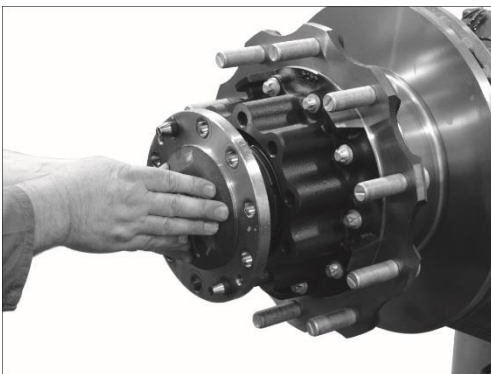


Figure 7

16. Push flange shaft into the hub carrier.

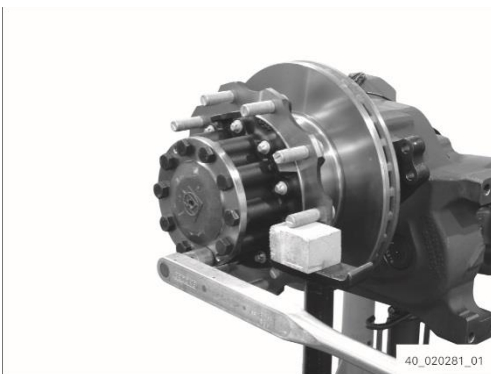


Figure 8

17. Fix hub by inserting the parking brake.
18. Turn in and tighten the screws.
Tightening torque: **440 Nm**



Checking of slotted nut-hub bolt connection on AVN 132

Safety instructions environment

Operating supplies and auxiliary materials may not be allowed to enter the soil, groundwater, or sewage system.

- Request material safety data sheets for the corresponding ZF products from your responsible environmental protection authority, and observe them.
- Collect operating supplies and auxiliary materials in a sufficiently large container.
- Dispose of operating supplies and auxiliary materials, waste, containers, soaked cleaning cloths, contaminated filters, etc. in accordance with the regulations of the environmental protection laws.
- Pay attention to the manufacturer's regulations and accident prevention regulations.

When selecting operating supplies and auxiliary materials, pay attention to health risks, environmental compatibility, disposal regulations and your country-specific opportunities to dispose of such materials properly.

For further safety instructions refer to the corresponding Repair Manual.

Requirements:

- Vehicle jacked-up.
- Wheels may remain on the vehicle.

Special tools:

- 5870.401.146 Slotted nut wrench



Figure 9

1. Fix hub by inserting the parking brake.
2. Loosen screws of the cover.
3. Observe safety instructions environment. Remove cover.
4. Unlock outer slotted nut.

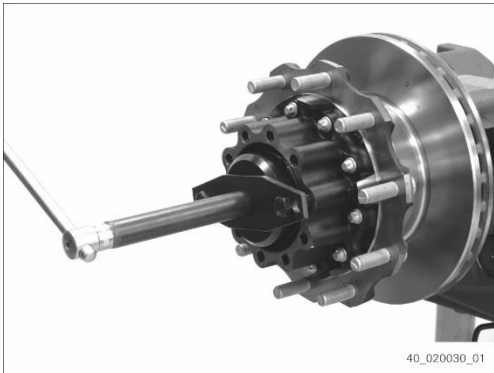


Figure 10

5. Loosen outer slotted nut with 5870.401.146 [slotted nut wrench].
6. Remove locking plate.
7. Loosen inner slotted nut with 5870.401.146 [slotted nut wrench].

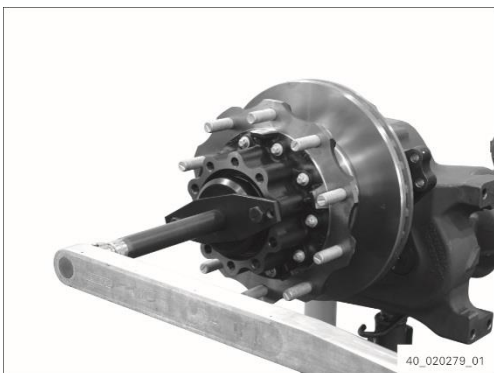


Figure 11

8. Tighten inner slotted nut with 5870.401.146 [slotted nut wrench].
Tightening torque: **100 Nm**
9. Rotate the hub in both directions several times.
10. Tighten inner slotted nut with 5870.401.146 [slotted nut wrench].
Tightening torque: **850 Nm**
11. Push **new** locking plate with tab pointing inwards onto the hub carrier.
12. Bolt on outer slotted nut with the chamfer pointing inwards.
13. Tighten outer slotted nut with 5870.401.146 [slotted nut wrench].
14. Tightening torque: **1200 Nm**

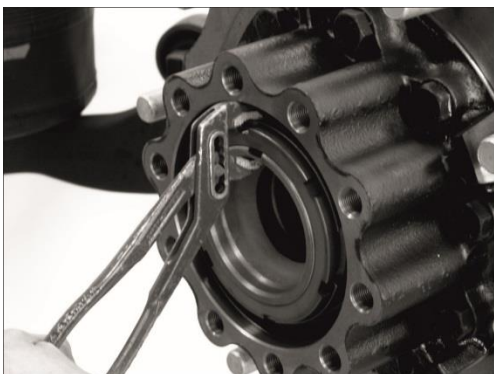


Figure 12

15. Secure outer slotted nut with locking plate.



Figure 13

16. Grease **new** O-ring and insert it into the annular groove of the cover.

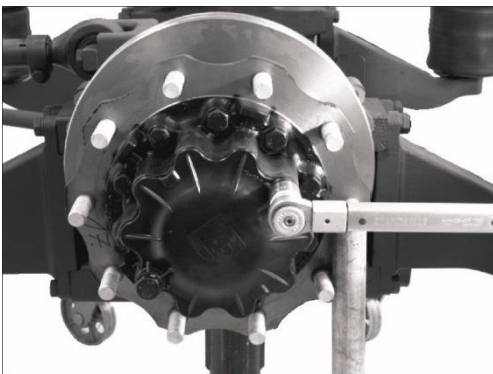


Figure 14

17. Insert cover until contact is obtained.
18. Fix hub by inserting the parking brake.
19. Turn in and tighten the screws.
Tightening torque: **100 Nm**