Structural Integrity and Performance of RL9-K005 REALLOCK$_{TM}$

References: RL9-K005 Advance Release, Revision 2
SP-1000: Limit Switch Random Vibration: Fighter Aircraft Applications

Objective:

The purpose of this testing is to determine the following for the redesigned REALLOCK$_{TM}$ RL9-K005 (advance release, revision 2):

1- verify capability to withstand 65 lbs-ft of fastener tightening torque
2 - determine application constraints for 65 lbs-ft of fastener tightening torque
3 - determine the number of allowable reuses and criteria for replacement
4 - assess performance in a vibratory environment with simulated loss of clamp load
5 - evaluate an epoxy adhesive as an alternative to projection welding

Results/Conclusions:

The following lists the conclusions and recommendations based upon the testing described above for REALLOCK$_{TM}$ RL9-K005, advance release revision 2 with projection welds:

1) the washer is capable of withstanding a maximum 65 lbs ft of applied fastener torque

2) no application constraints are required at 65 lbs ft of applied fastener torque

3) the product is capable of a minimum 10 reinstallations

4) the nut used should be of a hardness greater than or equal to the REALLOCK$_{TM}$ (43 Rc minimum) if the joint is to be used more than one.

5) the REALLOCK$_{TM}$ is shown to provide resistance to rotation when joint clamp load is lost.

6) the fastener was retained on the shaft without rotation for one hour duration of vibration in the SP-1000 environment (copy attached) after simulated loss of joint clamp load.

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4 - assess performance in a vibratory environment with simulated loss of clamp load
5 - evaluate an epoxy adhesive as an alternative to projection welding

Procedure:

The procedure for all structural tests was as follows:

1 - insert REALLOCK$_{TM}$ on the slotted and threaded shaft
2 - insert the shaft in the internally threaded cylinder a minimum of 5 turns
3 - line up the REALLOCK$_{TM}$ key with the slot in the cylinder
4 - turn the nut finger tight into the REALLOCK$_{TM}$
5 - apply torque to the test value. Record using a torque wrench
6 - remove nut and REALLOCK$_{TM}$
7 - observe condition and record findings

The test setup is illustrated in the photographs at the end of this report.

The procedure for the vibration test is as follows:

1 - Install the REALLOCK$_{TM}$ lock washers on the nut side of the fixture.
2 - Tighten the system to 50 lbs-feet and loosen to 10 lbs-feet.
3 - Apply the random vibration spectrum per SP-1000 for one hour.
4 - Repeat steps 1 through 3 with 12 inch pounds of fastener torque

Equipment Used:

CDI Dial Torque Wrench (0-100 lbs-ft scale)
CDI Dial Torque Wrench (0-75 lbs-in scale)
REALLOCK$_{TM}$ test fixture
UniMode C10E Vibration Test Machine
Umholz Dickey Power Amplifier

LDS DVC 4000 Vibration Controller

Background:

The key feature s of REALLOCK$_{TM}$ being tested is as follows:

The key feature and nut locking feature are positioned on separate parts.
The key feature is included in a separate machined part that significantly increases the rotational strength compared to the RL2 series key design.
Rotation between the two components is prevented with a 5 sided raised feature on the key component which is inserted into a similar opening in the nut locking feature component.
The parts are fastened together for shipping and installation purposes only.

Two fastening techniques between the component parts were evaluated: 1) projection welding and 2) epoxy adhesive.

Results and Discussion:

Sample 1 with projection welds was subjected to the structural and reuse test. The nut was tightened to 65 foot pounds. No mechanical damage was observed. The torque was increased to 100 foot pounds. No mechanical damage was observed. The nut was removed from the surface and the part examined. No mechanical damage was observed.

Sample 1 was subjected to the reuse test. The primary purpose of this test is to verify that the folds continue to engage the nut after repeated usages. This is determined by recording any changes to the height of the lobes. The results of the test is summarized in the following table:

Reuse #	Back off Torque		Lobe height		Comments
	From full clamp load	After 30˚ of nut rotation	#1	#2	
2	50	7	.157	.153	
3	50	7	.158	.158	
4	50	6	.155	.153	One projection weld failed
5	52	8	N.A.	N.A.	

Reuse #	Back off Torque		Lobe height		Comments
	From full clamp load	After 30˚ of nut rotation	#1	#2	
6	45	N.A.	.155	.151	
7	48	5	.155	.151	
8	50	N.A.	.155	.151	
9	49	3	.156	.152	Noted wear on the nut where it contacted the test piece.
10	45	4	.156	.151	

After 10 reuses, the sample was removed and the nut without any locking device was tightened to 65 foot pounds. The back off torque measured at 52 foot pounds. After 30˚ of nut rotation, there was no measurable torque.

The data indicates the following:

1) There is no degradation of the performance of the sample with reuses. This is indicated by the fact that the lobe height did not significantly change during the coarse of the test.

2) The performance of the joint was not degraded with the loss of one of the projection welds.

3) The nut showed signs of wear during the test as indicated by the loss of torque at 30˚ of rotation. The nut used was per SAE grade 2. In this grade the steel used is significantly softer than the REALLOCK$_{TM}$ and resulted in degradation of the nut. This test shows that the nut used should be of SAE grade 5 or greater material to reduce wear during reinstallation of the nut.

4) The comparison of the resisting torque after 30˚rotation with and without the REALLOCK$_{TM}$ clearly shows that the locking feature maintains resistance to motion after joint clamp load is lost.

Sample 2 with the epoxy adhesive was subjected to the structural test. The epoxy adhesive failed to maintain a structural joint while the pictures of the set up were being taken. This condition

indicates that the adhesive option is not viable. The nut was tightened to 65 foot pounds to verify that the anti rotation feature between the two components of this REALLOCK$_{TM}$ functions as intended. After locating the two components and securing them finger tight with the nut, the system was tightened to 65 foot pounds. No relative motion was observed between the two components.

Sample 3 was installed using the vibration test fixture and REALLOCK$_{TM}$ test fixture. Two cases were tested for one hour each.

Test Case 1: The nut was tightened to 50 lbs-ft and then loosened to 10 lbs-ft to simulate partial loss of clamp load. The random vibration spectrum per SP-1000 was applied for one hour. No nut rotation was observed.

Test Case 2: The nut was further loosed to 1 foot pound (12 inch pounds) and SP-1000 applied. After an initial nut rotation of approximately 20˚, the nut remained in the same position for the remainder of the test.

The above vibration tests verify that REALLOCK$_{TM}$ is capable of preventing the nut from rotating off the shaft when joint clamp load is lost.

Summary/Conclusions

The following lists the conclusions and recommendations based upon the testing described above for REALLOCK$_{TM}$ RL9-K005, advance release revision 2 with projection welds:

1) the washer is capable of withstanding a maximum 65 lbs ft of applied fastener torque

2) no application constraints are required at 65 lbs ft of applied fastener torque

3) the product is capable of a minimum 10 reinstallations

4) the nut used should be of a hardness greater than or equal to the REALLOCK$_{TM}$ (43 Rc minimum) if the joint is to be used more than one.

5) the REALLOCK$_{TM}$ is shown to provide resistance to rotation when joint clamp load is lost.

6) the fastener was retained on the shaft without rotation for one hour duration of vibration in the SP-1000 environment (copy attached)

7) The adhesive option to secure the two parts of the system together is not viable.