Use of Locknut for Prevention of Loosening Phenomenon in Bolted Joints

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Abstract

A large number of bolted joints and fasteners are used in making assemblies due to their advantage of ease in dismantling for maintenance purpose. Such joints self-loosen while they are subjected to dynamic loads. In this paper, finite element analyses (FEA) are carried out on bolted joints with and without a lock nut, subjected to dynamic transverse load to study its loosening behavior. Parameters like *bolt pretension* (F_P) and *locking force* (F_L) are considered for a few transverse loading cycles to understand the effectiveness of use the of a locknut in preventing loosening of the bolted joints. Results show that bolted joint with a lock-nut shows good resistance to self-loosening as compared to a standard bolted joint.

Keywords: Bolted joint, Lock-nut, FEA, Loosening of bolted joints.

1. Introduction and literature survey

It is important to understand causes of self-loosening and remedies to prevent it as it can lead to serious accidents. Junker [1] investigated experimentally the effect of transverse load on bolted joint. He found that the loosening of the bolted joint is very critical when the joint is subjected to transverse load. The effect of various secondary locking mechanism in the joint are tested experimentally which reduces the extent of loosening in the bolted joint [2]. They found that the double nut mechanism and adhesive joint shows more resistance to self-loosening, but still significant loosening of the joint was detected. Sakai et.al [3] numerically studied loosening in the bolted joint with lock nut and spring washer.

Procedure to carryout FEA

The Finite Element (FE) model created in accordance with experimental setup used by Junker [1]. Only essential parts of the assembly are modeled for FEA as shown in Figure.1 in order to reduce computational time and cost [4]. The bolted joint is modeled according to DIN 931 standard with bolt size M10. Bolt pretension (F_P) is applied to the bolt and a cyclic transverse displacement load of amplitude ±1 mm is applied to the clamped plate.

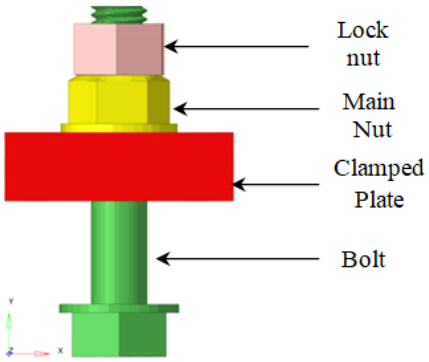

Figure 1. FE model of Bolted joint with lock nut

The steady state dynamic analyses are carried out. Preload decay in the joint and nut turn angle is observed.

2. Results and Discussion

Since the transverse displacement is applied to the clamped plate, it will cause the bolt to bend in the direction of applied force. Due to bending of bolt, reaction forces change at the contact interfaces causing slip at the threaded and nut bearing contacts. Due to the occurrence of slip, the loosening in the joint is observed. It is observed that loosening occurred due to complete slip at the threaded contact and nut bearing contact. Variation in preload for various values of locking force is shown in Figure 2 (a). The preload decay shows that the extent of loss of preload is reduced as an increase in the force in the lock-nut. The nut turn angle is found to be increasing monotonically with the number of cycles as shown in Figure 2(b).

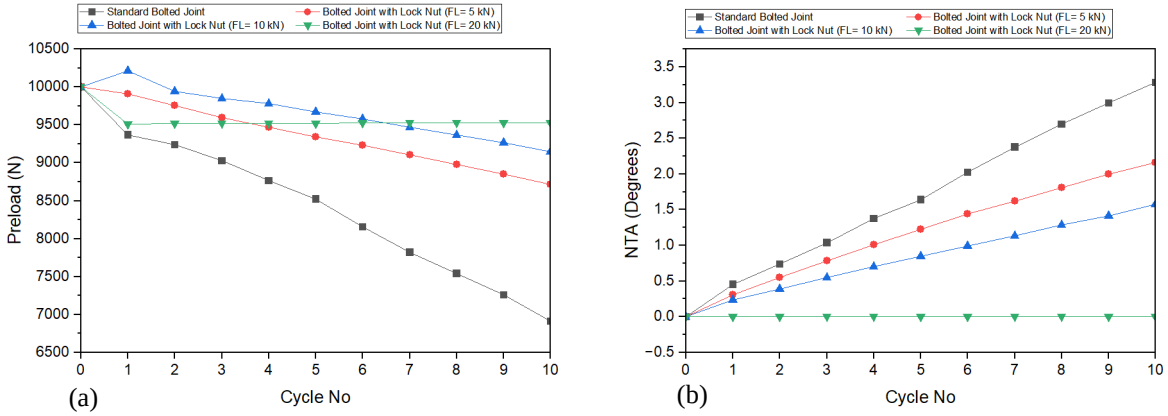

Figure.2. (a) Preload decay curve, (b) Nut Turn Angle (NTA) during ten loading cycles (F_P=10 kN)

3. Conclusion

From the simulation it is found that the bolted joint with a lock-nut will show good self-loosening resistance as compared to standard bolted joint. Further, it is also found that the resistance to loosening will be more when locking force is more than preload.

References

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