The Effect of Macro Fiber Reinforcements on Mechanical Behavior of Single Lap Adhesively Bonded Joints in two Different Orientations

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Abstract
Adding particles and fibers to the adhesive layer is a method suggested to improve the stress distribution and to increase the strength and toughness of adhesive joints. In this paper, the effects of adding the metal fibers and also the reduction of fiber horizontal distance on distribution of peel stress and shear stress were also investigated in joint width, which was indicative of the significant effect of the metal fibers in the transverse configuration. Meanwhile, reduction of the horizontal distance between the metal fibers in the transverse direction first degrades the peel stress and then improves it. Despite the trend observed for the peel stress with the transverse direction, the distribution of the shear stress with reduction of the horizontal distance between the metal fibers becomes more uniform and the maximum values of shear stress regularly decreases in the joint length due to considerable load sharing of the metal fibers in the adhesive layer. In addition to the analyses carried out on the distribution of stress in the joint lengths, the distribution of peel stress and shear stress were also investigated in joint width, which was indicative of the significant effect of the metal fibers in the transverse configuration.
3- Solid element
Tables 1

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Fig.1 Single lap joint geometry and embedded metallic fibers in the adhesive layer

Fig.2 Finite element model and boundary condition of single lap joint reinforced by metal fibers with the longitudinal direction

Fig.3 Peel stress distribution along the joint length in the various horizontal distance at the longitudinal direction

Fig.4 Peel stress distribution along the joint length in the various horizontal distance at the longitudinal direction

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شکل ۵ توزیع نیروی پلی در جهت‌گیری عرضی

Fig.5 Peel stress distribution in the adhesive layer with the lateral direction
Fig. 6 Shear stress distribution in the adhesive layer with the lateral direction.
4- جمع‌نمایی و توجه‌گری

کاهش مقادیر پیشنهاد شده آن نسبت به پوشک‌های مشابه است. این نتایج نشان می‌دهد که با افزایش فاصله افقی پوشک‌های فلزی برای برخی محصولات، این نتایج برای برندهایی که در راستای عرض اصلاح می‌شود، این برای هرگونه است که در جهت‌گیری طولی، نتایج توزیع پوشک‌های مقادیر نشان می‌دهد اصلاح غیر اکارکتر می‌شود.

[گرافیک 3D پول استرس در لایه پوشک با距ینی افقی ابتدایی مابین ماهیتی و آلوده‌های فلزی با آنتی‌زایش و لازم‌های طولانی و عرضی پوشک‌های تعریف شده است. در جهت‌گیری طولی، توزیع نشانه‌های پوشک‌هایی برای بخش‌های غیر مشابه نشان می‌دهد.]

**Fig. 7** The comparison of 3D peel stress distribution in the adhesive layer at the minimum horizontal distance between the metal fibers ($a = 0.3$) with unreinforced adhesive a unreinforced adhesive b) adhesive reinforced by metal fibers with longitudinal direction c) adhesive reinforced by metal fibers with lateral direction

شکل 7 مقایسه پول استرس به مدت نشانه‌های پوشک‌هایی در لایه ابتدایی مابین ماهیتی و آلوده‌های فلزی ($a = 0.3$) با جدید پوشک‌شما، نشان می‌دهد که پوشک‌های طولانی و عرضی در جهت‌گیری طولی نشانه‌های پوشک‌هایی برای بخش‌های غیر مشابه نشان می‌دهد.
Fig. 8 The comparison of 3D shear stress distribution in the adhesive layer at the minimum horizontal distance between the metal fibers \( (a' = 0.3) \) with unreinforced adhesive a) unreinforced adhesive b) reinforced by metal fibers with longitudinal direction c) adhesive reinforced by metal fibers with lateral direction

The high load sharing of the metallic fibers reducing the shear stress level of the adhesive layer

The work effect of the lateral direction on improving shear stress distribution along the joint length

The improvement of the shear stress distribution along the joint width reinforced by metallic fibers with the lateral direction.
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