Evolution of the Von Mises Stress of a Cracked Plate

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Abstract

To promote prevention must study the behavior of these structures in the case of accidents, as shocks to prolong the lifetime of the structures. To predict the dynamic behavior of structures under the impact effect, we addressed the dynamic problem as a modeling and a numerical resolution. Indeed, this work is part of the dynamic impact study on a cracked plate. Our choice focused on numerical simulations to examine the response of a cracked plate aluminum alloy impacted by a spherical projectile diameter of 40 mm. A comparison was made with the case of a healthy plate flawless dynamically biased in the same conditions.

Keywords

Cracked plate, impact, dynamic, modeling, numerical simulation, aluminum alloy, projectile

1. INTRODUCTION

The collision is the structural impact between two solids or other rigid obstacles affect the safety of some structures [1-5]. The dynamic analysis of cracked plates was performed by several authors. Some authors require previous knowledge of the impact force others involve as part of the problem [6] and suggest its determination at the same level with the resulting stresses, the arrow, the deformation…ect, [7- 12]. In this study we present the modeling and numerical simulation of impact dynamics of a rigid spherical projectile on a flexible plate cracked in order to see the evolution of the stress Von Mises.

The behavior of the plate when shock was analyzed in terms of stress and deformation. The influence of the crack size on the dynamic response of the plate was also discussed.

2. DIMENSIONS OF THE CRACKED PLATE AND THE PROJECTILE

The table below summarizes the dimensions of the fissured plaque and the projectile

Table 1. Geometrical characteristics of the plate and projectile

Structure	Dimension
Plate (target)	Length L = 400 mm Width l = 200 mm Thickness t =3 mm
Sphere (projectile)	Radius of the sphere R = 20 mm
Initial distance between the plate and the sphere	d =10 mm

3. DYNAMIC DATA

The cracked plate is supposed flexible while the sphere is taken as a rigid form the data speed and duration of impact are the following[13]:

1) Speed of projectile v = 45m/s,
2) Impact duration t = 0,02s.

The geometry of the cracked plate and the sphere is given by Figure 1and Figure 2.

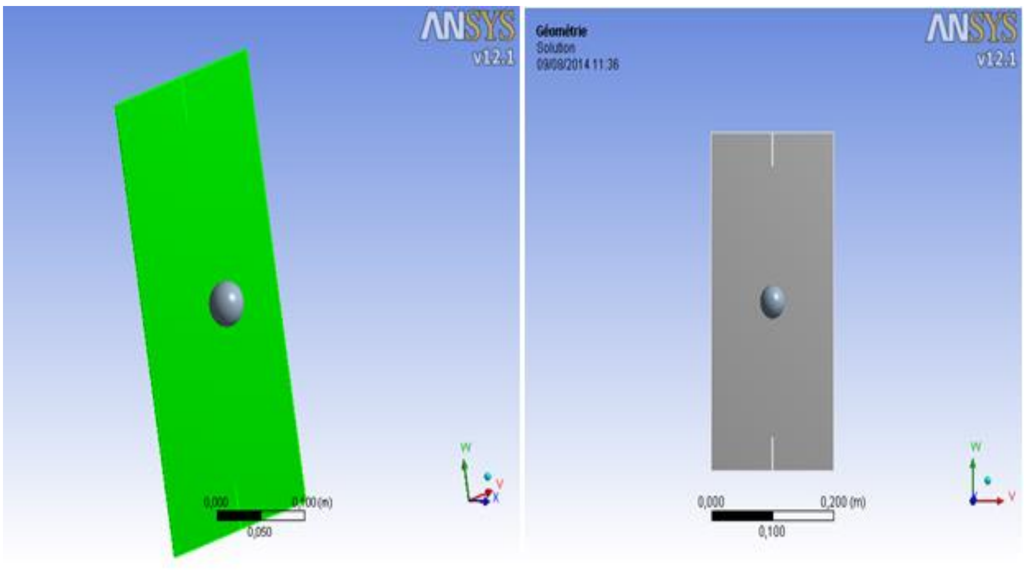


Figure 1. Geometry of the plate and the sphere.

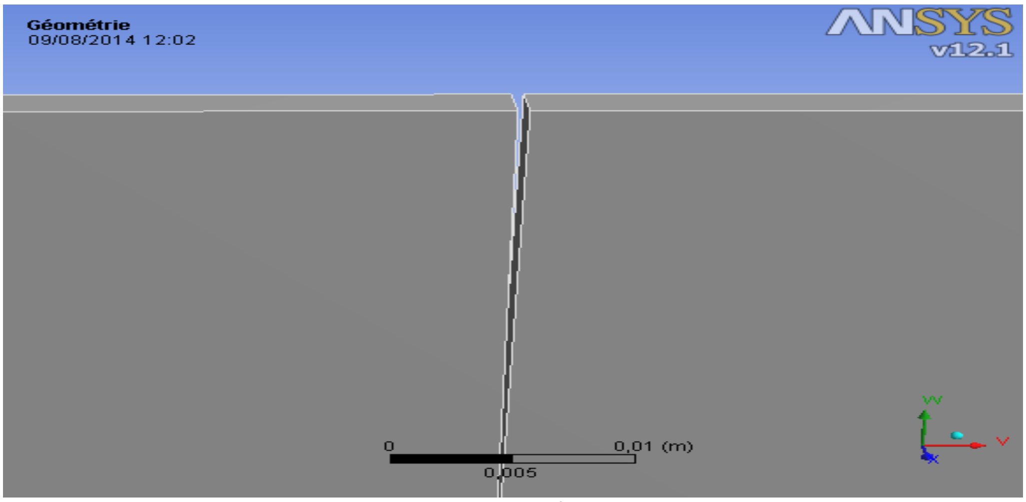


Figure 2. Geometry of the cracked.

4. MECHANICAL CHARACTERISTICS OF THE CRACKED PLATE AND THE PROJECTILE

The mechanical characteristics of the cracked plate and the projectile are given in the following table (See table 2.

Table 2. Mechanical characteristics of the cracked plate and the projectile

Material	Density ρ (kg/m^3)	Young's modulus E (N/m^2)	Poisson coefficient ν	Mass m (kg)
Alloy aluminum plate	2770	7,1E +10	0 ,33	0,66463
Projectile in steel	7850	2E+11	0.3	0.263

5. BEHAVIOR ANALYSIS OF THE CRACKED PLATE UNDER THE EFFECT OF THE IMPACT BY A SPHERICAL PROJECTILE

For modeling and numerical simulation of the effect of the projectile impact on the cracked plate, the code ANSYS (workbench) has been used. The boundary of conditions applied to the cracked plate is defined by a recess of two un cracked edges of the plate in Figure 3.The mesh of the cracked plate and the sphere are shown in Figure 4.

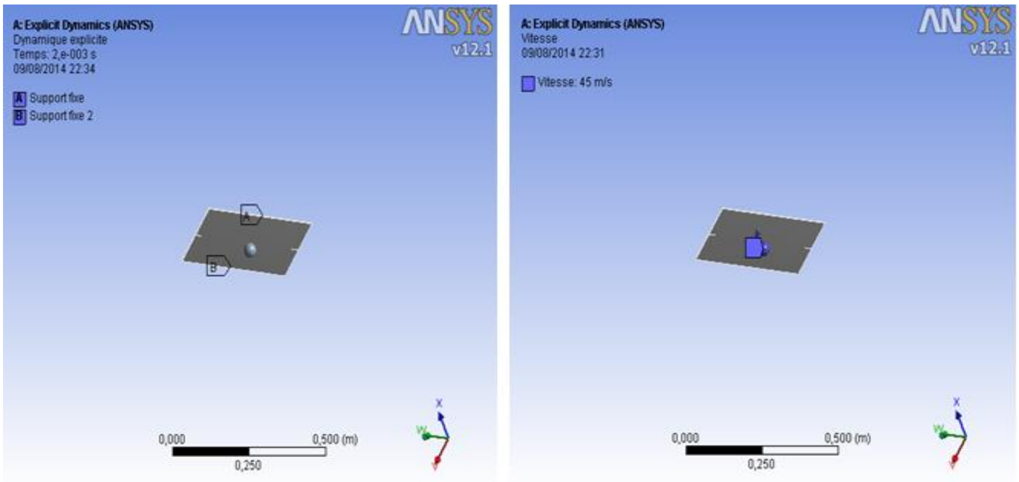


Figure 3. Boundery of conditions applied to the plate.

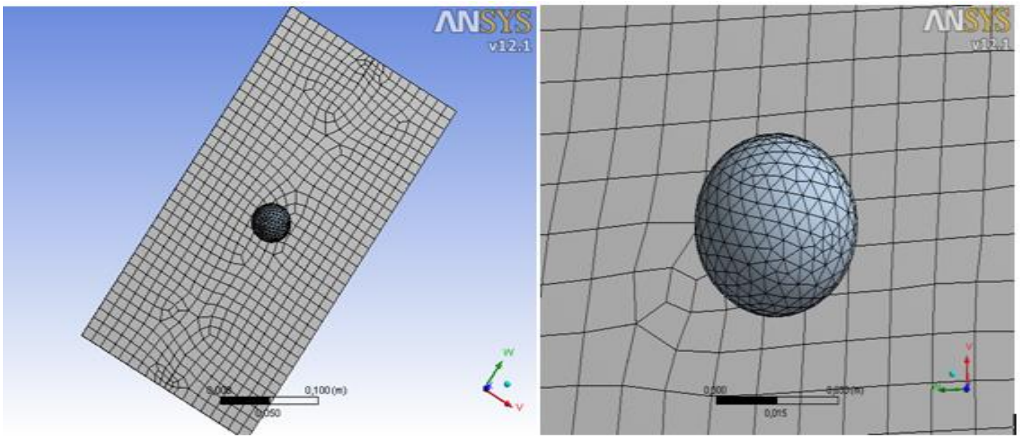
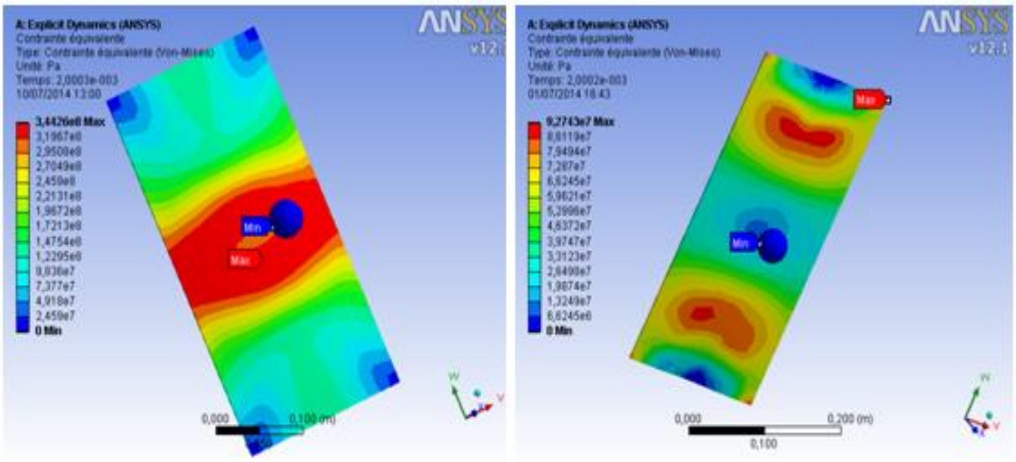


Figure 4. Mesh of the plate and the sphere.

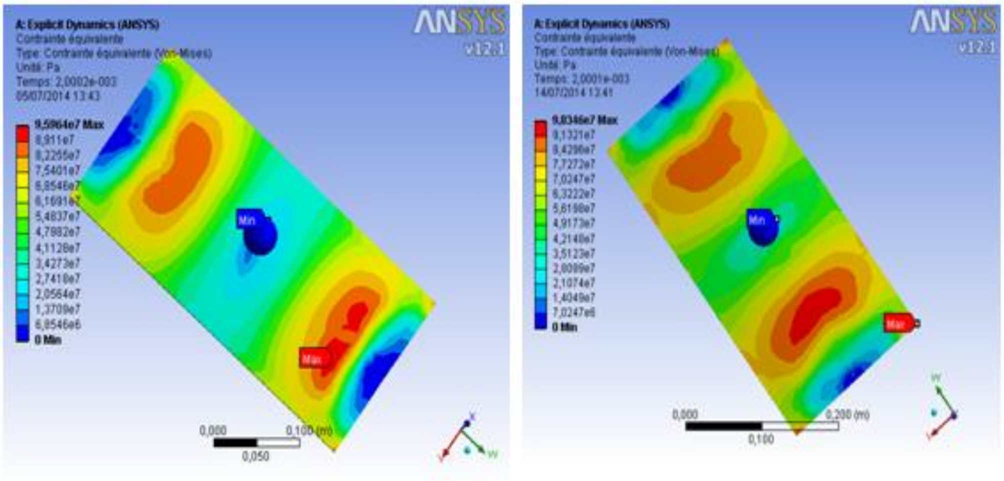
6. RESULTS AND DISCUSSIONS

6.1 Constraints of Von Mises

The constraints of Von Mises at the moment of impact are shown in Figure 5.

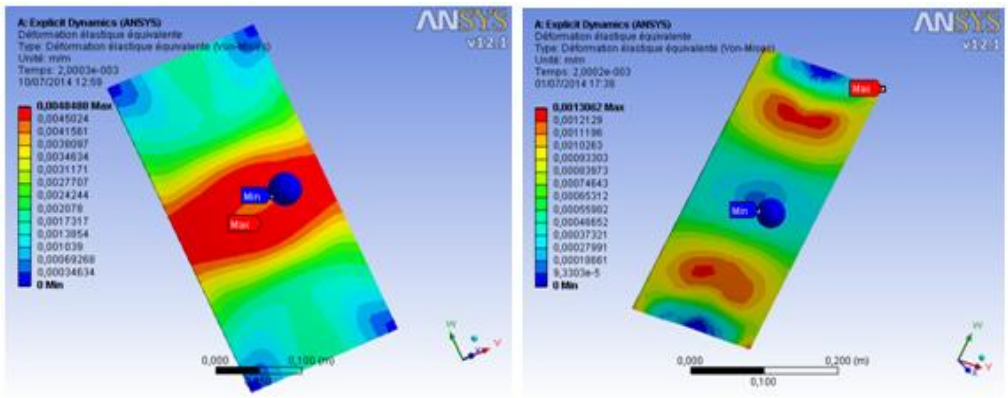


(a) Equivalent stress a /w = 0 (b) Equivalent stress a /w = 0,063

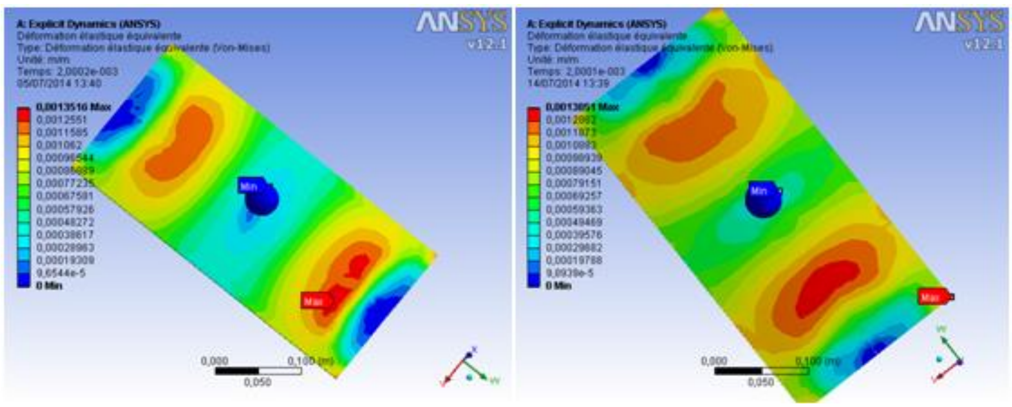


(c) Equivalent stress a /w = 0,075 (d) Equivalent stress a /w = 0,1

Figure 5. Constraint of Von Mises for an impact speed 45m/s and for different crack lengths.



(a) Equivalent elastic deformation a /w = 0 (b) Equivalent elastic deformation a /w = 0,063



(c) Equivalent elastic deformations a /w = 0,075 (d) Equivalent elastic deformations a /w = 0,1

Figure 6. Elastic deformations of Von Mises.

The figure 5and figure 6, represent the constraint distribution along the cracked plate and the uncrack plate.

For the uncrack plate is embedded on both sides Fig. 6(a),we can deduce that the elastic constraint of Von Mises and the elastic deformation of Von Mises are highest around the point of contact and they gradually diminish to the corners of the edges of the plate.

For the three cracked plate figures 6(b), 6(c) and 6(d), it is found that the constraint field is maximum in the zone located near the tip of the crack then it decreases gradually as and when that one moves to the free edges of the crack. In addition, the constraints in the point are very weak.
The constraint filed is inversely proportional to the crack length.

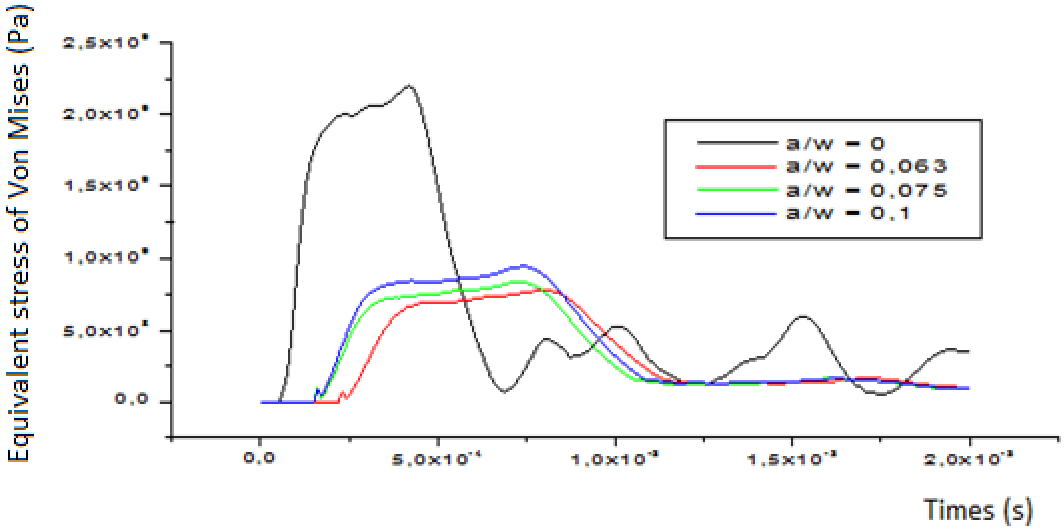


Figure 7. Evolution of the constraint of Von Mises versus time for an impact speed of 45m/s.

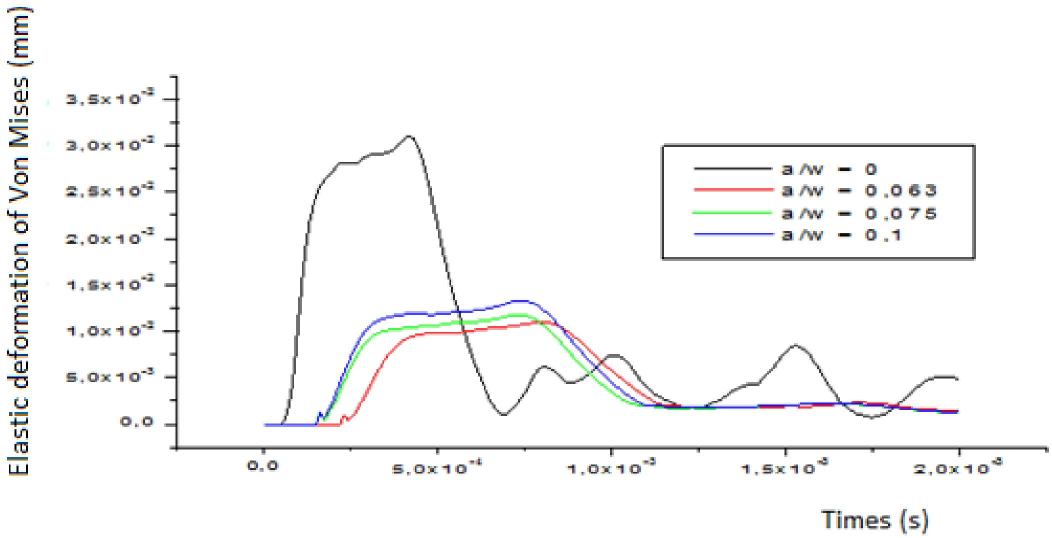


Figure 8. Evolution of the demonstration of Von Mises versus time for an impact speed of 45m/s .
The figure 7 and Figure 8, represents that for the three cracked plates, the curves of elastic constraint and elastic deformations of Von Mises have the same paces and they pass through three phases, the first phase comprises two stages; the first stage correspond to the contact between the plate and the sphere, and the second one sees the level of constraints and the deformations arise with damage caused by the difference between potential energy and kinetic energy of the two structures (the energy of the impactor is greater than that of the plate).The second phase is when damage is present with peaks of constraints and deformations. The third phase is the damage where a portion of the energy used to make up the impactor, it is the phenomenon of the rebound.

7. CONCLUSION

The study allowed us to understand the behavior of a healthy plate and a cracked plate under the effect of a dynamic impact of spherical projectile types. It was found that the healthy plate had a higher dynamic behavior as that of an identical cracked plate at the edges. for the un craked plate, at the moment of the impact, the deformations and the constraints are maximal around the contact point so for the cracked plate ,these are highest in the vicinity of cracks peacks. Increasing the length of the edges of cracks has an influence on the dynamic behavior.
Of the cracked plate through the evolution of constraints and dynamic deformations.

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Biography

Bourdim Mokhtar is currently a fulltime senior lecturer and Head of Mechanical Engineering Department at Relizane University Ahmed Zabana in Algeria, holds a Bachelor of Science degree, a Master and a Phd in manufactoring process from Higher National School of Education Oran in Algeria.

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