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# Compressive impact of SiC foam

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**Abstract:** The silicon carbide (SiC) can be used for its foam production. It is used for infiltrated composites fabrication. In this paper, a problem of an impact of a steel plate travelling with high velocity hitting a silicon carbide sample (SCF) is considered. The presentation concerns the modes of failure and degradation.

**Keywords:** SiC, silicon carbide foam, impact, compression, peridynamics

## 1. Introductory statement

The SCF material stands for the skeleton of the infiltrated metal/SCF composites. Therefore, a study is undertaken to elaborate numerical modelling of the SCF under impact conditions.

## 2. Problem statement

In peridynamics, the model is dependent on peridynamics states [1]. The deformation of the body is shown in Fig. 1(a). The bond definition, the reference state and the deformation state are defined in Eq. (1). The scalar state definition and decomposition into the spherical and deviatoric parts is given in Eq. (2). The force state is given in Eq. (2) as well, where k is the bulk modulus, $x=|\xi|$ is the scalar state, θ is the dilatation, $m$ is the weighted volume, $\alpha=15\mu/m$ depends on the shear modulus $\mu$.

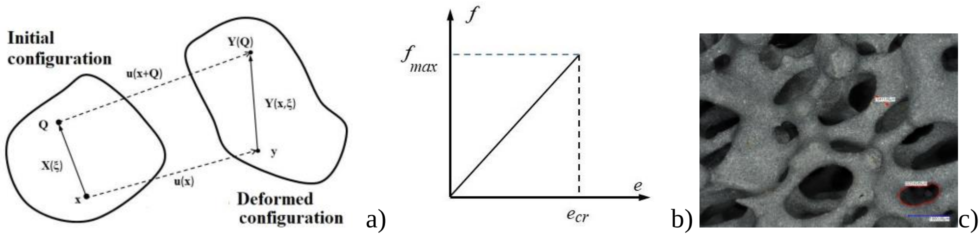


**Fig. 1.** Deformation of the peridynamic body (a), constitutive law (b), SCF sample under consideration.

$$\boldsymbol{\xi}=\mathbf{Q}-\mathbf{x}, \quad \mathbf{Y}(\mathbf{x},\boldsymbol{\xi})=\mathbf{y}(\mathbf{Q})-\mathbf{y}(\mathbf{x}), \quad \mathbf{U}(\mathbf{x},\boldsymbol{\xi})=\mathbf{u}(\mathbf{Q})-\mathbf{u}(\mathbf{x}) \tag{1}$$

$$e(\mathbf{Y})=|\mathbf{Y}|-|\mathbf{X}|, \quad e=e^i+e^d, \; t(\mathbf{Y})=\left(3k\theta/m\right)\omega x+\alpha\omega e^d, \tag{2}$$

A particular case of the state model is the bond based model shown in Eq. 2 (left). The force in a bond is proportional to the constant $c=18h/\pi/h^4$, where $h$ is the radius of the horizon, namely, the sphere in which the integration is done.

$$f = ce\varsigma(\mathbf{x},t,\xi), \quad e_{cr} = \sqrt{5G_{ci}/(9kh)}, \quad d(x,t) = 1 - \int_{\Omega} \varsigma(x,t,\xi)\,d\Omega \Big/ \int_{\Omega} d\Omega \tag{3}$$

The critical stretch is given in Eq. (3) in the middle, Fig. 2(b), where the $G_{ci}$ is the fracture energy corresponding with the crack mode I. The damage variable *d* is equal to 0 for the pristine material and 0 for the damaged.

## 3. Demonstrative example

An example of dynamic compression is shown in Fig. 2. The physical image of the SCF is shown in Fig. 1(c). The SCF sample of the dimensions 34.7 mm height, 8.9 mm thick and 18.6 wide is dynamically compressed by a steel piston with the velocities of 40 m/s and 385 m/s. The time of the process is 3.06E-05 s. The material properties of the SiC: Young’s modulus 430.0 GPa, Poisson’s ratio 0.37, mass density 3200 kg/m$^3$, fracture toughness 4.1 MPa.m$^{1/2}$. The base and the piston are made of steel with Young’s modulus 210 MPa, Poisson’s ration 0.3 and mass density 7800 kg/m$^3$.

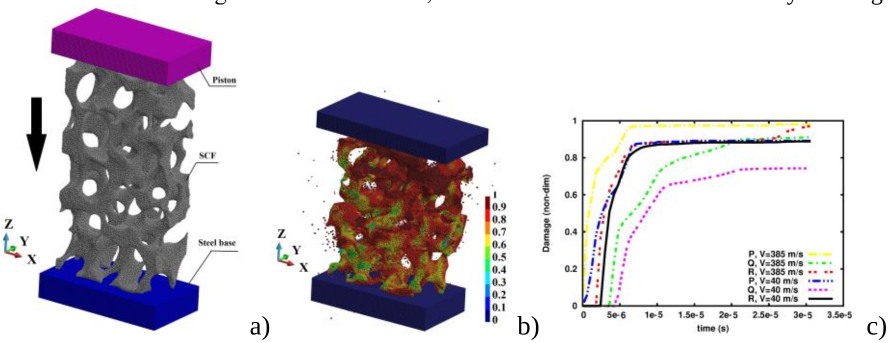


**Fig. 2.** Scheme of the structure (a), deformed configuration (b), damage-time dependence for 385 m/s and 40 m/s piston velocity at points P, Q, R.

The scheme is shown in Fig. 2(a). The deformed structure under the piston velocity 385 m/s is given in Fig. 2(b). The structure exhibits fragmentation and self-contact between the branches of the pores. In Fig. 2(c), the damage dependence on time at the selected points is presented for the two velocities of the piston. The points P, Q and R are placed close to base, in one-third of the height of the SCF and close to the piston, respectively. Damage appears earlier and is higher in the case of higher piston velocity than in the case of the lower one.

## 3. Concluding Remarks

An outline of the numerical modelling with peridynamics is presented. In the Author’s opinion, it is a promising tool to evaluate the behaviour of the considered materials even though it requires up-to-date high-performance computers (HPC) to obtain the results in a reasonable time.

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