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2D Hopkinson bar simulation analysis

Al 6061-T6 specimens

A. Bouamoul
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Defence R&D Canada – Valcartier
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Technical Memorandum
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Abstract

Mechanical behaviour at high strain rate, e.g. explosive charges, high velocity impact or blast, differs from that observed at quasi-static strain rate. At high strain rates, the material deforms at rates between 10^3 s^{-1} to 10^6 s^{-1}. The split Hopkinson bar is one of the most common experimental methods used to obtain material properties at high strain rates.

In this memorandum, the LS-DYNA hydrocode was used to model the mechanical behaviour of Aluminum 6061-T6. A brief review of the theory of the split Hopkinson pressure bar and an analysis of mesh sensitivity are included. To validate the numerical results, the dimensions of the bars and the striker used are the same as those used in experimental tests. The bars and the striker are cylindrical and made of Maraging steel. The bars and the striker have lengths of 800 and 200 mm, respectively, with the same diameter of 14.5 mm. Because of the axi-symmetry nature of the problem, only half of the model was used for the simulation. Different striker velocities were simulated. The results show the existence of a linear relationship between the striker velocity and the compressive wave travelling through the incident bar.

Résumé

Le comportement mécanique à des taux élevés de déformation comme les charges explosives, l'impact à haute vitesse et la surpression diffère de celui observé en régime quasi-statique. À des taux élevés, un matériau se déforme à un rythme qui se situe entre 10^3 s^{-1} et 10^6 s^{-1}. La barre de Hopkinson est une des méthodes expérimentales les plus utilisées pour obtenir les propriétés des matériaux à des taux élevés de déformation.

Dans ce mémorandum, l'hydrocode LS-DYNA a été utilisé pour modéliser le comportement de l'aluminium 6061-T6. Une brève description de la théorie de la barre de Hopkinson ainsi qu'une analyse de l'influence du maillage sur les résultats numériques sont incluses dans ce document. Afin de valider les résultats numériques, les caractéristiques géométriques de l'impacteur et des barres sont identiques à celles utilisées dans les tests expérimentaux. Les barres et l'impacteur sont de forme cylindrique et faits d'un acier connu sous le nom de *Maraging steel*. Les barres et l'impacteur ont une longueur respective de 800 et 200 mm ainsi qu'un diamètre commun égal à 14,5 mm. En raison de l'axisymétrie du modèle numérique, la simulation a été réalisée à deux dimensions. Différentes vitesses d'impacteur ont été simulées. Les résultats montrent l'existence d'une relation linéaire entre la vitesse d'impact et l'amplitude de l'onde compressive qui traverse la barre initiale.

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Executive summary

Under high dynamic loading conditions, e.g. explosive charges, high velocity impact or in blast regime, material properties are different from those in quasi-static regime. The published data are principally based on quasi-static tests in which the material is deformed statically with an average strain rate of about 10^{-1} s^{-1} or less. During ballistic impact or under blast loading conditions, the strain rate could exceed, in some cases, 10^5 s^{-1}. To obtain material properties such as Young's modulus, yield stress and elongation at high strain rates, a dynamic test method is required. The split Hopkinson bar is the most commonly used method for determining dynamic material properties. The basic method was first introduced in 1949. However, many laboratories are now using split Hopkinson bar apparatus with modifications that provide different loading conditions and a variation of data acquisition systems. The need to have these high strain rate properties has led Defence Research and Development Canada (DRDC) Valcartier to develop the split Hopkinson bar.

Hydrocode models are now available to model ballistic events or blast. However, to model these events correctly, accurate high strain material properties are required. In this memorandum, the hydrodynamic finite element code LS-DYNA, was used to model the split Hopkinson bar. The use of LS-DYNA helped reduce the number of experimental set-ups and provide answers to initial related design questions such as characteristics of the striker and bars.

The test material used in simulations is Al 6061-T6, which is independent of strain rate effects. A quick review of mathematical analysis involved in split Hopkinson bar and an analysis of mesh sensitivity are included. In the case where the sample has a length of 5 mm and a diameter of 10.5 mm, the numerical results were compared with experimental data. The comparison shows good agreement between the model prediction and the experiment. Five striker velocities, 17.3, 20.4, 25.6, 29.9 and 37.2 m/s, were simulated. The numerical results show that the amplitude of the compressive wave is directly proportional to striker velocity.

This work was done at DRDC Valcartier in September and October 2004 under Work Breakdown Element (WBE) 12rg05 'Study of Armour Materials'.

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Sommaire

En régime de chargement dynamique, par exemple, les charges explosives, l'impact à haute vitesse ou la surpression, les propriétés des matériaux sont différentes de celles en régime quasi-statique. Les données publiées sont surtout basées sur des tests quasi-statiques dans lesquels le matériau est déformé statiquement selon un taux de déformation qui n'excède pas 10^{-1} s^{-1}. Durant l'impact à haute vitesse ou la surpression, le taux de déformation peut dépasser 10^{5} s^{-1}. Afin de connaître les propriétés des matériaux comme, le module de Young, la limite d'écoulement ou l'allongement à la rupture à des taux élevés de déformation, une méthode de test dynamique est alors nécessaire. L'appareil, connu sous le nom de "*split Hopkinson pressure bar*", est l'une des méthodes les plus utilisées pour tester les matériaux en régime dynamique. Cette méthode a été d'abord introduite en 1949. Actuellement, plusieurs laboratoires utilisent cette technologie avec quelques modifications au mode de chargement et à la façon d'enregistrer les données expérimentales. Le besoin de connaître ces propriétés a mené le centre de recherche et développement pour la défense Canada Valcartier (RDDC Valcartier) à mettre au point cette barre.

Les hydrocodes constituent un des outils de simulation numérique capables de modéliser des événements balistiques et de surpression. Cependant, la fiabilité des résultats numériques nécessite l'utilisation de propriétés dynamiques. Dans ce mémorandum, l'hydrocode d'éléments finis LS-DYNA a été utilisé pour la simulation numérique de la barre d'Hopkinson. De même, l'utilisation de ce logiciel a permis de diminuer le nombre de tests expérimentaux et toutes les autres questions reliées aux caractéristiques des barres et de l'impacteur.

Le matériau utilisé dans les simulations est l'aluminium 6061-T6 qui est indépendant du taux de déformation. Une revue de l'analyse mathématique des équations de la barre de Hopkinson a été présentée ainsi que l'influence du maillage sur les résultats numériques. Dans le cas où l'échantillon a une longueur de 5 mm et un diamètre de 10,5 mm, les résultats numériques ont été comparés aux données expérimentales et validées. Cinq différentes vitesses d'impacteur ont été modélisées, soit 17,3, 20,4, 25,6, 29,9 et 37,2 m/s.

Les résultats numériques ont montré que l'amplitude de l'onde compressive est directement proportionnelle à la vitesse de l'impacteur.

Ce travail a été réalisé à RDDC Valcartier en septembre et octobre 2004 dans le cadre du projet 12rg05 '*Study of Armour Materials*'.

Bouamoul, Amal. 2005. 2D Hopkinson bar simulation analysis, Al 6061-T6 specimens. DRDC Valcartier, TM 2004-363. Recherche et développement pour la défense Canada.

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Acknowledgements

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1. Introduction

To accurately model ballistic impact problems or material response to blast, it is necessary to work with accurate high strain rate material properties. Most often, the data published in the literature are based on quasi-static tests for which the specimens are deformed uniformly with an average strain rate of about 10^{-1} s^{-1} or less.

In the high strain rate domain, the most common method used for determining dynamic material properties is the split Hopkinson bar. The Hopkinson bar consists of a striker bar, an incident bar, the specimen, a transmitted bar and a momentum trap. The incident and transmitted bars can be made of two different materials. However, to simplify the mathematical calculations, the two bars are most often made of the same material. Figure 1 shows a basic Hopkinson bar test set-up.

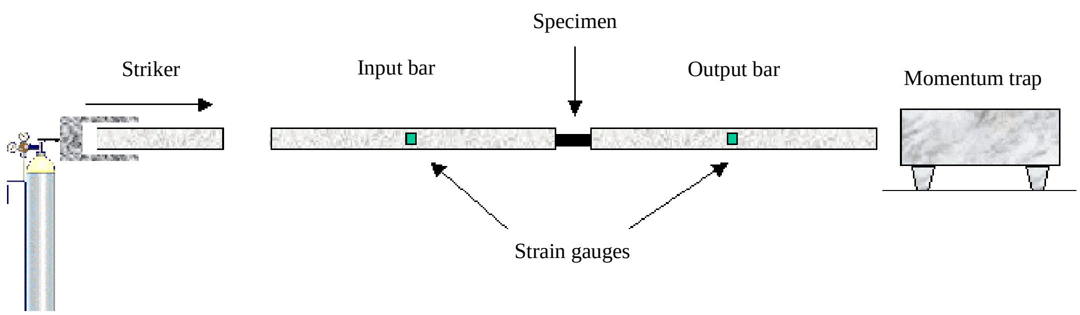

Figure 1. *Representation of a split Hopkinson bar*

In a split Hopkinson bar, when the striker hits the incident bar, a rectangular compression wave with a specific amplitude and length moves through the length of the incident bar. The compressive wave is a function of the velocity and shape of the striker. When the wave reaches the end of the incident bar, a fraction of it is transmitted to the specimen and some is reflected. This is due to the mismatch in the cross-sectional area and acoustic impedance between the bars and the specimen. The wave transmitted by the specimen to the transmitted bar is a function of specimen material properties.

The use of one-dimensional wave propagation analysis helps to determine high strain rate stress-stain curves from measurements of strain gauges in the incident and transmitted bars (Ref. 1). To simplify the mathematical analysis, a one-dimensional wave equation, given by equation 1, can be used to describe wave displacement in the incident bar. Equation 2 is a solution to the second order differential equation given by equation 1.

$$\frac{\partial^2 u}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2 u}{\partial t^2} \tag{1}$$

$$u_1 = f(x - ct) + g(x + ct) = u_i + u_r \tag{2}$$

where c is the sound speed in the incident and transmitted bar, u_1, u_i and u_r are respectively, the total, the incident and the reflected displacement wave into the incident bar. Assuming a one-dimensional system with respect to time, the strain in the incident bar can be determined by differentiating equation 2 and the following equation can be written.

$$\dot{u}_1 = c\left(-\frac{\partial f}{\partial t} + \frac{\partial g}{\partial t}\right) = c(-\varepsilon_i + \varepsilon_r) \tag{3}$$

Where ε_i and ε_r are, respectively, the incident and reflected strains. In the split Hopkinson bar test before the reflection occurs at the end of the transmitted bar, only a single wave travels along it. With this assumption, equations 4 can be written as:

$$\dot{u}_2 = -c\varepsilon_t \tag{4}$$

where ε_t is the transmitted strain and u_2 is the displacement wave in the transmitted bar. Figure 2 gives a view of the incident bar, the specimen and the transmitted bar.

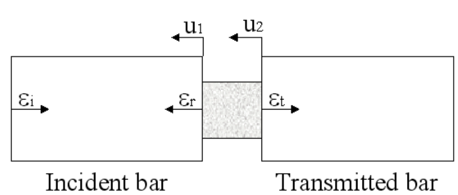

Figure 2. *Expanded view of incident bar, specimen and transmitted bar*

Equation 5 gives the strain rate in the specimen. Using equations 3, 4 and 5, equation 6 can be obtained.

$$\dot{\varepsilon}_{specimen} = \frac{(\dot{u}_1 - \dot{u}_2)}{l_s} \tag{5}$$

$$\dot{\varepsilon}_{specimen} = \frac{c}{l_s}\left(-\varepsilon_i + \varepsilon_r + \varepsilon_t\right) \tag{6}$$

Where, l_s is the instantaneous length of the specimen and $\dot{\varepsilon}_{specimen}$ is the strain rate in the specimen. Using the definition of the forces in the incident [$F_i = AE(\varepsilon_i + \varepsilon_r)$] and transmitted bars [$F_t = AE\varepsilon_t$] and assuming that the specimen deforms uniformly, the transmitted strain can now be expressed as:

$$\varepsilon_t = \varepsilon_i + \varepsilon_r \tag{7}$$

In the last three equations, A is the cross-sectional area of the incident and transmitted bars, E is the Young's modulus of the bars and A_s is the cross-sectional area of the specimen.

The relationship expressing the strain rate in the specimen, given by equation 8 below, can be obtained by substituting equation 7 into equation 6. Also, the stress in the specimen can be calculated by dividing the force in the transmitted bar by the cross-sectional area of the specimen and equation 9 can be obtained.

$$\dot{\varepsilon}_{specimen} = \frac{2c\varepsilon_r}{l_s} \tag{8}$$

$$\sigma_{specimen}(t) = \frac{AE\varepsilon_t}{A_s} \tag{9}$$

2. Experimental tests

2.1 Experimental test set-up

The photograph shown in Fig. 3 gives a view of the experimental test set-up viewed from the incident bar end.

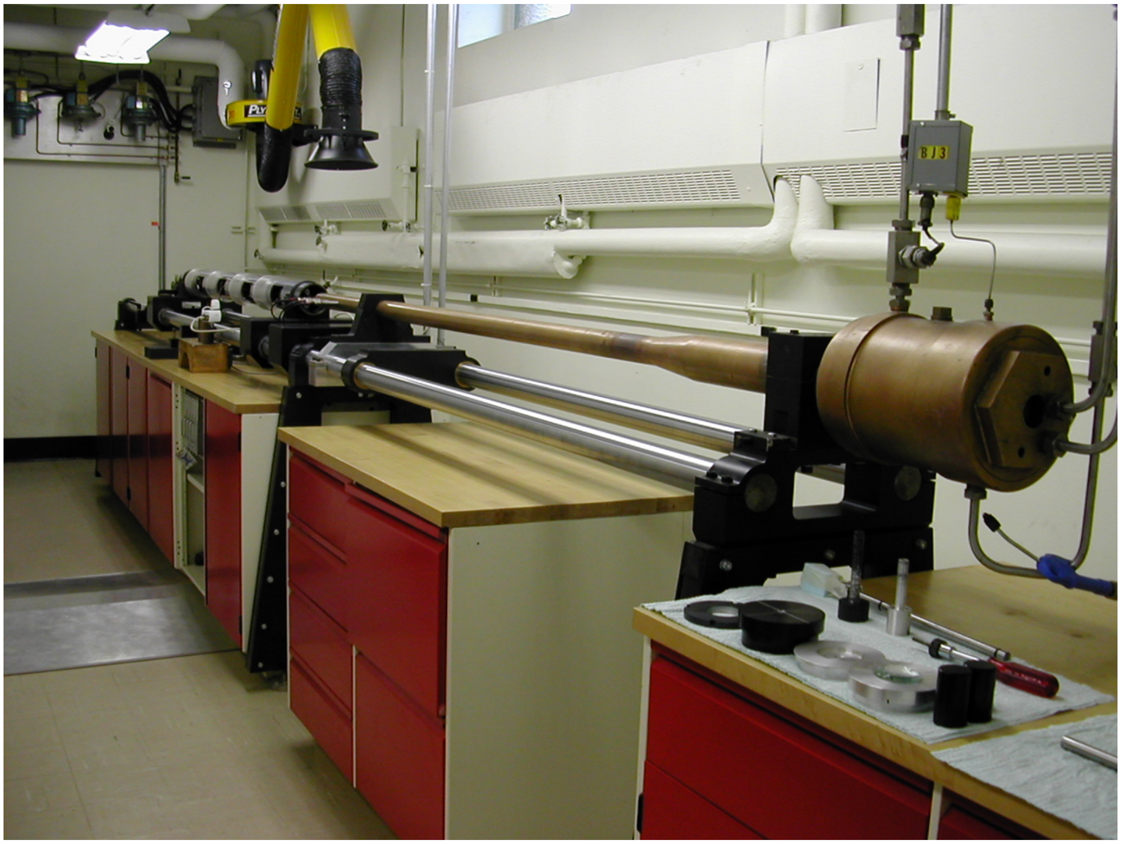

Figure 3. *View of experimental set-up at DRDC Valcartier*

To propel the striker, a gas gun was used. Using different pressures, the striker velocity was varied between 10 and 40 m/s. The specimen's and bars' dimensions were chosen carefully with respect to two basic conditions. The first condition is that the specimen must deform uniformly without mushrooming, whereas the second one is that the wave propagation must be one-dimensional. In addition to the two conditions, other parameters must be taken into account. For instance, material properties of the incident and transmitted bars, striker velocity and shape of the bars also need to be accounted for. Reference 2 provides a detailed discussion of these parameters.

To validate the numerical results, the dimensions of the bars and striker are the same as those used in experimental tests. The striker, the incident and the transmitted bars were cylindrical and made of Maraging steel. The striker and the bars diameters were 0.0145 m, whereas the length of the bars and the striker were 0.8 m and 0.2 m, respectively.

2.2 Specimen characteristic

The use of the split Hopkinson pressure bar to measure material dynamic properties depends on several factors of which, perhaps, the most important being specimen geometry. The dimensions of the specimens were designed in accordance with some basic principles and are discussed in detail in Reference 2. The specimen characteristics used in experimental tests are presented in Table 1. Only numerical results for the first specimen dimensions are presented in this document.

Table 1. *Specimen characteristics*

DIAMETER (mm)	**LENGTH** (mm)
10.5	5.20
11.0	5.47
11.5	5.72
12.0	5.97
12.5	6.22
13.0	6.47

3. Numerical model

LS-DYNA is a general-purpose implicit/explicit finite element code used to analyze the non-linear dynamic response of three-dimensional inelastic structures (Ref. 3). It was used to simulate the experimental tests conducted with the DRDC Valcartier Hopkinson bar facility. A two-dimensional shell mesh of the Hopkinson bar was created using FEMAP 8.3 package (Ref. 4). As a tool for post-processing, LS-POST was used to analyze the results.

3.1 Material properties

Mat_3 in LS-DYNA is a kinematic-isotropic elastic-plastic hydrodynamic material model. It was used to simulate specimen material response. This model implies a bilinear stress/strain curve. To reduce the CPU time, Mat_1 which is an isotropic elastic material was used to simulate the bars.

The specimen and bar materials are Aluminum 6061-T6 and Maraging steel, respectively. Their characteristics are given in Table 2 (Ref. 6). In the case of Maraging steel, the density and the elastic modulus of bars were measured experimentally (Ref. 2). In all the simulations, a perfect contact between the bars and specimen was assumed and the frictional forces were ignored.

***Table 2**. Material properties used for simulation*

PHYSICAL PARAMETERS	BARS AND STRIKER	SPECIMEN
	Maraging steel	***Al 6061-T6***
Density, ρ (kg/m^3)	8064	2690
Yield Strength, σ_y (Pa)	N/R	335 E+06
Elastic Modulus, E (Pa)	182 E+09	73.08 E+09
Poisson's Ratio, ν	0.3	0.33
Tangent Modulus, E_t, (PA)	N/R	645.7 E+06
Failure Strain, f_s	N/R	0.54

N/R: Not Required

3.2 Numerical mesh

To model the impact between the bars and the specimen, the physical domain of the problem was divided into smaller regions called elements, where each element is connected with others through nodes. A special consideration had been taken when meshing the sample and the adjacent impacted zones of the incident and transmitted bars. The shape and the size of the elements could influence the results. Because of the axisymmetric nature of the simulation, only half of the problem was modeled, therefore using a two-dimensional simulation. Four-node quadrilateral elements were used.

3.2.1 Mesh sensitivity analysis

To model accurately the impact between the bars and the specimen, the incident and transmitted bars were separated into two regions, namely I and II, as shown in Fig. 4.

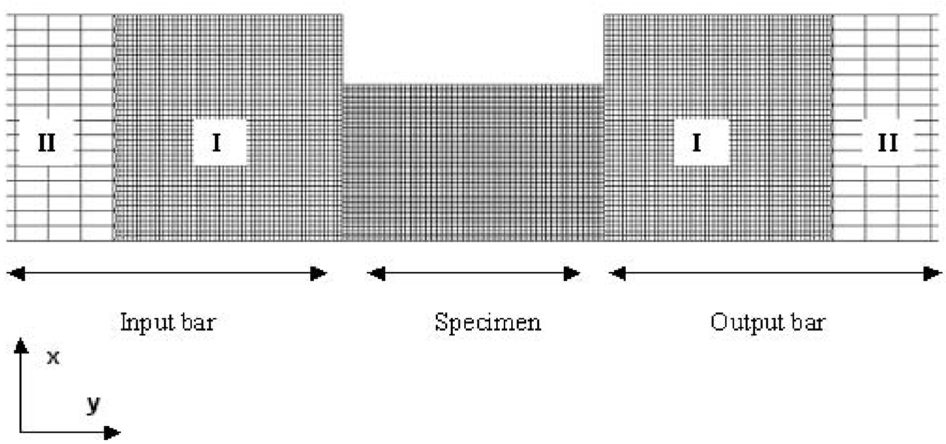

Figure 4. *Typical finite elements mesh used for simulation*

Numerical simulations showed that region I is exposed to large stress variations; consequently, it was finely meshed. Alternatively, region II was meshed with less elements because the stress was the same along the horizontal elements. Table 3 gives the mesh distribution used in numerical simulations.

Table 3. *Meshed densities and dimensions used in numerical simulation*

PHYSICAL PARAMETERS	SPECIMEN	INCIDENT AND TRANSMITTED BARS	
		Region I	***Region II***
Mesh density (elements/mm^2)	78.02	44.6	2.07
Length, L_y (mm)	5	7	793
Number of elements in y direction	32	50	793
Radius, R (mm)	5.25	7.25	7.25
Number of elements in radius direction (x)	64	45	15

Figure 5 and 6 give an idea of the results obtained by refining the mesh in region II. The simulations were performed on a specimen with a length of 5 mm and a diameter of 10.5 mm, whereas, the striker velocity was 17.3 m/s.

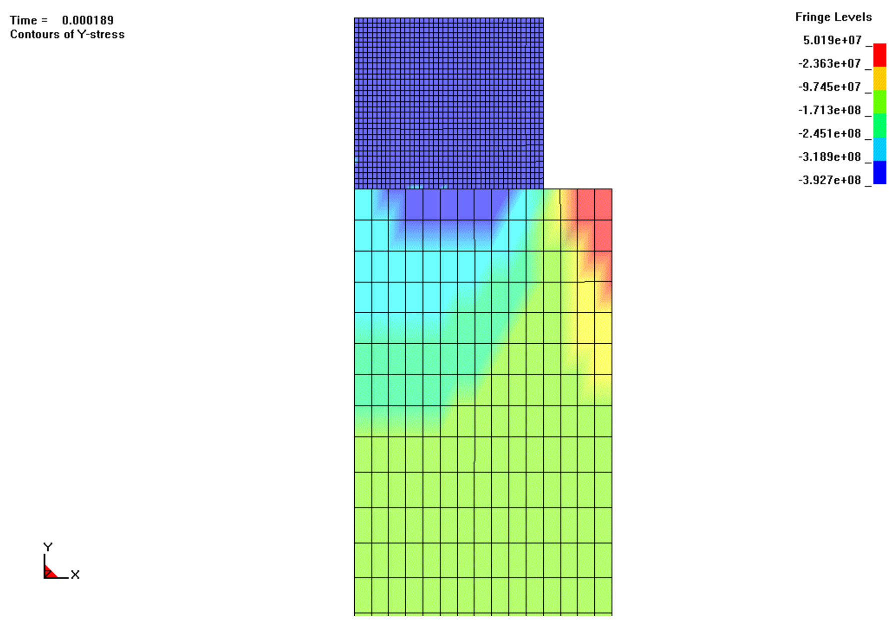

Figure 5. *Radial stress contours with less elements in region I ($V_{striker}$ = 17.3 m/s)*

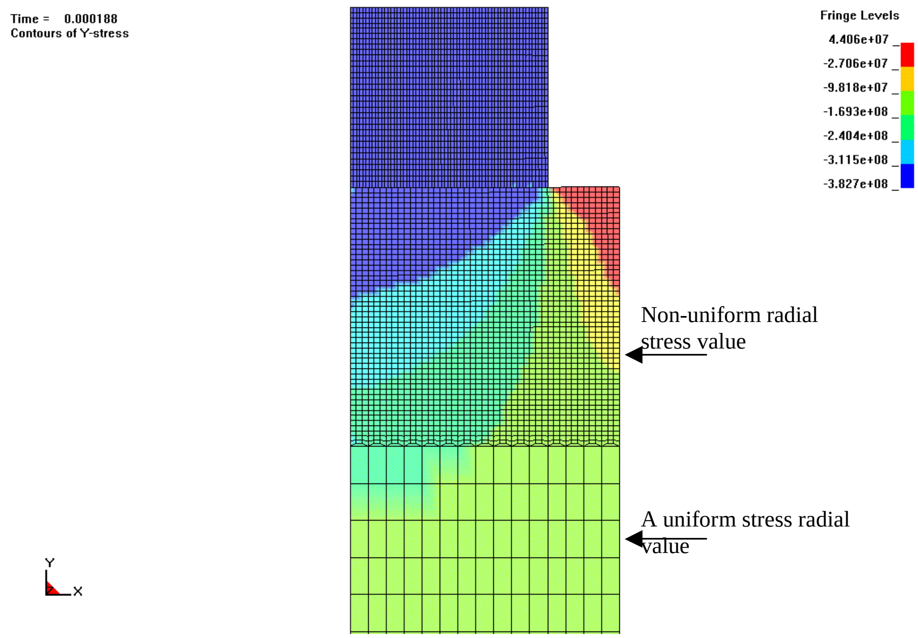

Figure 6. *Radial stress contours with fine elements in region I ($V_{striker}$ = 17.3 m/s)*

4. Results and Analysis

Figure 7 shows a typical progression of the stress wave as a function of time. The radial stress contours were plotted at times: 0, 1.66 ms, 1.70 ms, 1.88 ms and 2.56 ms.

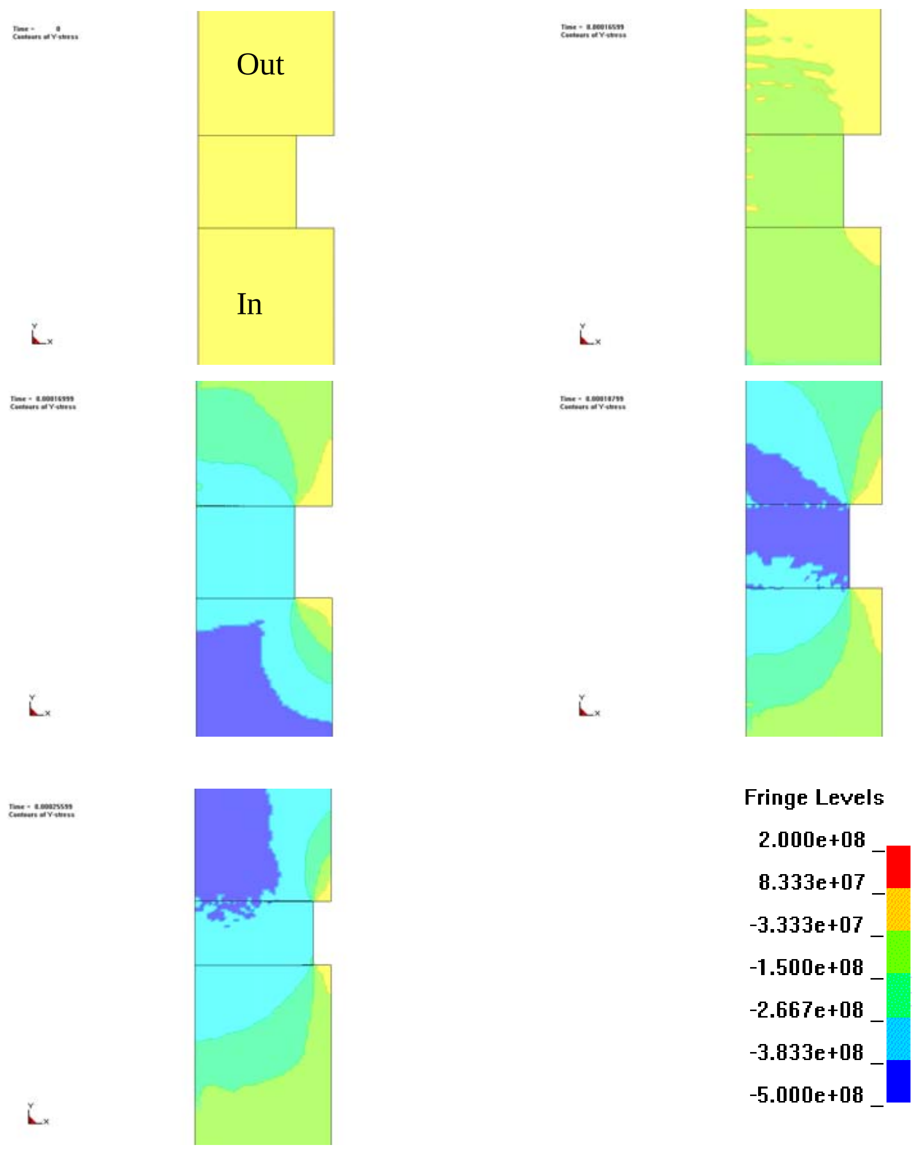

Figure 7. *Typical output given by LS-POST at different times*

The simulation was performed using a striker velocity of 35 m/s. After 3 ms, the length of the sample decreased from 5 to 3.48 mm.

Pertinent data from numerical output include stress and strain in the specimen and bars, average stress and the displacement history in the sample. In this document, stress-time history was given rather than strain history. If the radial strain is needed, radial stress can be divided by Young's modulus, since the bars and sample are subject to a normal force. Figure 8 shows stress as a function of time. Upon impacting the incident bar, the striker generated a compressive wave that travelled along the incident bar. In the case shown below, the incident and the output signals are given at the centre of the bars. After 80 µs from the time impact, the compressive wave arrives at the middle of the incident bar. The amplitude of the compressive wave in the incident bar reaches an average value of 380 MPa. At 175 µs a fraction of the wave is transmitted to the specimen, while the remainder is reflected as a tensile wave. The same phenomenon takes place between the sample and transmitted bar. The average stress transmitted to the transmitted bar is about 320 MPa, whereas; the reflected wave through the incident bar generated a stress of about 50 MPa.

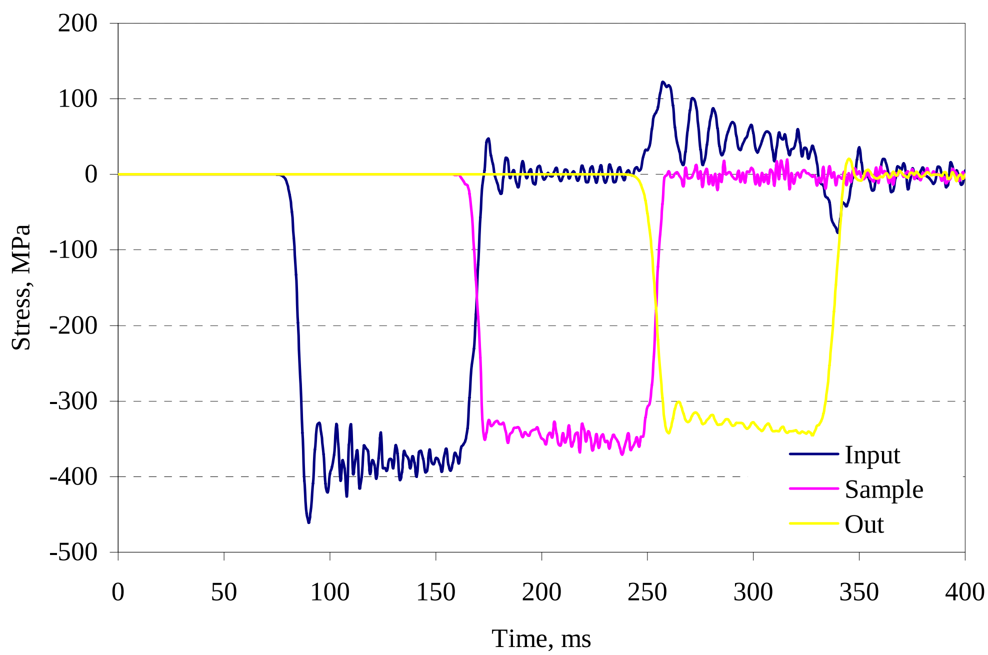

Figure 8. *Incident and transmitted radial stress (D_{sample}=10.5 mm, L_{sample}=5 mm, $V_{striker}$ =35.5 m/s)*

The amplitude of the wave travelling into the incident bar, the sample and the transmitted bar can be calculated using two formulations. The first one is the velocity of each part in contact (incident bar/sample, sample/transmitted bar) must be equal given the assumption of a perfect contact. The second one is that the forces on each side must satisfy the balance condition, thus they must be equal.

With these two assumptions, velocity continuity and force balance, equations 10 and 11 can be written between the incident bar and the specimen.

$$\left(\frac{\sigma_{incicent} - \sigma_{reflected}}{\rho c}\right)_{input\ bar} = \left(\frac{\sigma_{incicent}}{\rho c}\right)_{specimen} \tag{10}$$

$$\left(A\left(\sigma_{incicent} + \sigma_{reflected}\right)\right)_{input\ bar} = \left(A\sigma_{incicent}\right)_{specimen} \tag{11}$$

Where ρ, c and A are respectively, the density, sound velocity and cross-sectional area. The same formula can be written for the response between the specimen and the transmitted bar.

4.1 Comparison with experimental test

To validate the numerical simulations, a series of experimental tests were performed. A comparison with the experiment was made for the different sample geometries given in Table 1, even though only one case is presented in this document. The case presented is for a sample with a diameter of 10.5 mm and a length of 5 mm. As shown in Fig. 9, good agreement was achieved between the model prediction and the experiment. The only difference between the experiment and the simulation is the delay in the reflected signal. In fact, the tensile numerical wave arrives 5 μs later than the experimental one. This slight difference is probably due to the numerical process in which several idealized assumptions were made and these may have caused the predicted waveform to occur later than the measured time.

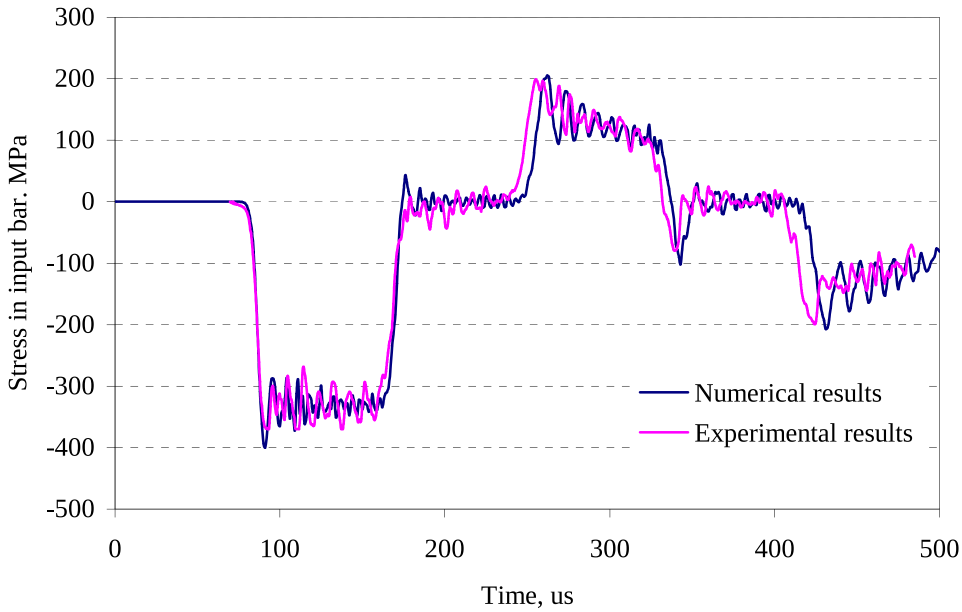

Figure 9. *Comparison between experimental and numerical results for the incident bar (D_{sample}=10.5 mm, L_{sample}=5 mm, $V_{striker}$ =17.3 m/s)*

4.2 Effect of striker velocity

Figure 10 shows numerical simulations for Al 6061-T6 specimens using different striker velocities. The characteristics of the specimen are the same as those used for comparison purposes with experimental data. Five different striker velocities were used in numerical simulations: 17.3, 20.4, 25.6, 29.9 and 37.2 m/s. All numerical results were compared and validated with the experiments. As the velocity of the striker increases, the amplitude of the compressive wave generated increases as well. Indeed, the length or the duration of the compressive pulse generated in the incident bar is twice the wave-transit time in the striker bar and the magnitude is directly proportional to the striker's velocity, as shown in Fig. 11. Of course, the formula $\left(S_y = 18.8\,V_s\right)$ is only applicable to the incident bar and the striker's characteristics described in Paragraph 2.1.

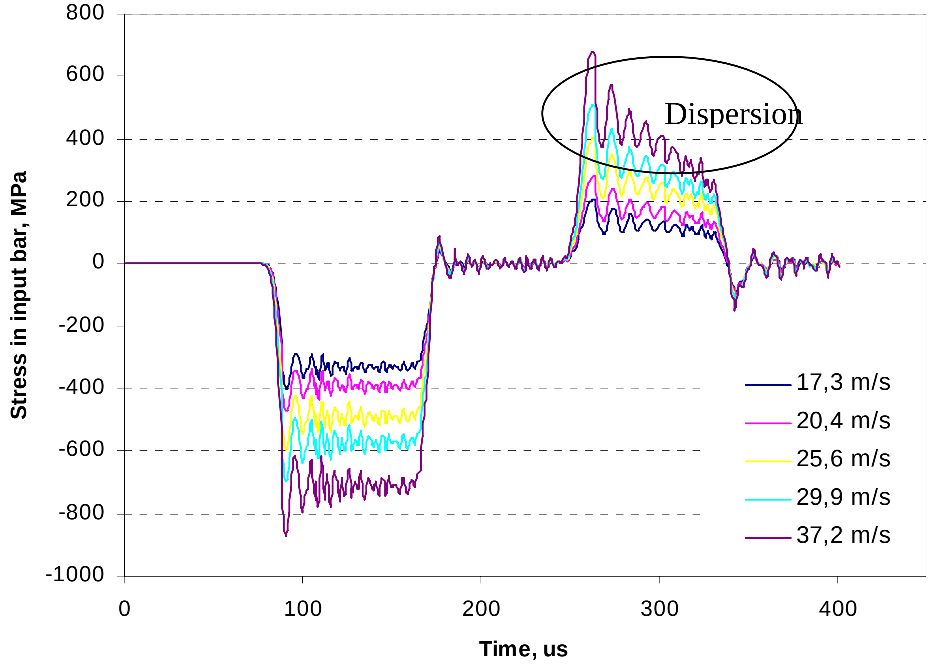

Figure 10. *Effect of striker velocity on the stress generated in the incident bar*

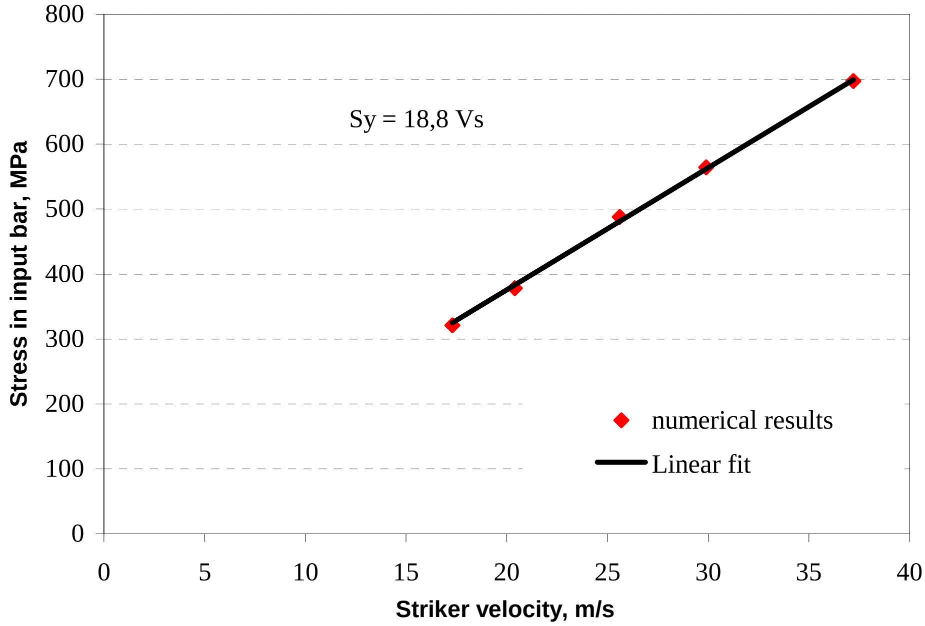

Figure 11. *Linear relationship between striker velocity and stress in the incident bar*

The assumption of non-dispersiveness of the elastic pressure waves in the bars, or in other terms, one-dimensional wave propagation analysis, is not entirely correct, especially when striker velocity exceeds 20 m/s, as shown Fig. 10. The dispersion phenomenon is the effect of the wave propagation velocity dependency on wavelength (Ref. 5). A theoretical dispersion correction can be made using Fourier's transform and Pochhammer-Chree frequency equation (Ref. 5). A first step is to transform the time-domain signals into the frequency domain and de-phase each component by a specific angle to compensate for bar dispersion. The second step is to transform the obtained signal back to the time-domain. Those manipulations were not done since it was not the aim of the current work. The dispersion phenomenon will be discussed in detail in future work.

5. Conclusion

The split Hopkinson bar is one of the most common experimental methods used to characterize material at high strain rates. This technique is used to measure stress-strain response of materials at high strain rates, typically in the range of 10^3 s^{-1} to 10^6 s^{-1}. Using LS-DYNA hydrocode, a two-dimensional split Hopkinson pressure bar was modeled. The characteristics of the bars and the striker were the same as those used in experimental tests. The specimen was made of Al 6061-T6, whereas the bars and the striker were made of Maraging steel. The theory governing the behaviour of the Hopkinson bar is reported.

A sample mesh sensitivity study indicated that the incident and transmitted bars must be divided into two meshed parts to capture accurate wave propagation. Different Al 6061-T6 specimens were modeled and compared with the experimental results. Although the numerical results are shifted forward by a small time interval, a good comparison was obtained. The slight difference, 5 μs, is attributed to the numerical process; in which several idealized assumptions were made. These assumptions could cause the predicted waveform to occur later than the measured ones. Five different striker velocities were used in the numerical simulations. The results show that as the velocity of the striker increases the amplitude of the compressive wave generated also increases. The results presented indicate that the assumption of non-dispersiveness of the elastic pressure waves in the incident and transmitted bars are not totally accurate, especially when striker velocity exceeds 20 m/s. In fact, the propagation of elastic waves through the incident and transmitted bars is described by one-dimensional wave theory. This assumption is not correct since wave propagation velocity is dependent on the wavelength. This phenomenon will be studied in future work.

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List of symbols/abbreviations/acronyms/initialisms

A	Cross-sectional area of the incident or transmitted bar
A_s	Cross-sectional area of the specimen
c	Sound speed of the bars
D_{sample}	Diameter of the sample
E	Young's modulus of the bars
F_i	Force in the incident bar
F_t	Force in the transmitted bar
L_{sample}	Length of the sample
l_s	Instantaneous length of the specimen
u_i	Incident wave
u_r	Reflected wave
u_1	Wave in the incident bar
u_2	Wave in the transmitted bar
v_s	Velocity of the striker
ε_i	Incident strain
ε_r	Reflected strain
ε_t	Transmitted strain
DND	Department of National Defence

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Mechanical behaviour at high strain rate, e.g. explosive charges, high velocity impact or blast, differs from that observed at quasi-static strain rate. At high strain rates, the material deforms at rates between 10 3 s-1 to 10 6 s-1. The split Hopkinson bar is one of the most common experimental methods used to obtain material properties at high strain rates.

In this memorandum, the LS-DYNA hydrocode was used to model the mechanical behaviour of Aluminum 6061-T6. A brief review of the theory of the split Hopkinson pressure bar and an analysis of mesh sensitivity are included. To validate the numerical results, the dimensions of the bars and the striker used are the same as those used in experimental tests. The bars and the striker are cylindrical and made of Maraging steel. The bars and the striker have lengths of 800 and 200 mm, respectively, with the same diameter of 14.5 mm. Because of the axi-symmetry nature of the problem, only half of the model was used for the simulation. Different striker velocities were simulated. The results show the existence of a linear relationship between the striker velocity and the compressive wave travelling through the incident bar.

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Le comportement mécanique à des taux élevés de déformation comme les charges explosives, l’impact à haute vitesse et la surpression diffère de celui observé en régime quasi-statique. À des taux élevés, un matériau se déforme à un rythme qui se situe entre 10 3 s-1 et 10 6 s-1. La barre de Hopkinson est une des méthodes expérimentales les plus utilisées pour obtenir les propriétés des matériaux à des taux élevés de déformation.

Dans ce mémorandum, l’hydrocode LS-DYNA a été utilisé pour modéliser le comportement de l’aluminium 6061-T6. Une brève description de la théorie de la barre de Hopkinson ainsi qu’une analyse de l’influence du maillage sur les résultats numériques sont incluses dans ce document. Afin de valider les résultats numériques, les caractéristiques géométriques de l’impacteur et des barres sont identiques à celles utilisées dans les tests expérimentaux. Les barres et l’impacteur sont de forme cylindrique et faits d’un acier connu sous le nom de Maraging steel. Les barres et l’impacteur ont une longueur respective de 800 et 200 mm ainsi qu’un diamètre commun égal à 14,5 mm. En raison de l’axisymétrie du modèle numérique, la simulation a été réalisée à deux dimensions. Différentes vitesses d’impacteur ont été simulées. Les résultats montrent l’existence d’une relation linéaire entre la vitesse d’impact et l’amplitude de l’onde compressive qui traverse la barre initiale.

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