Tran. Natl. Acad. Sci. Azerb. Ser. Phys.-Tech. Math. Sci.
Mechanics, **42** (7), 12-14 (2022)

Normal impact by assymmetric wedge on a flexible elastic thread

Tahir J. Mammadov

Received: 02.03.2022 / Revised: 12.05.2022 / Accepted: 30.05.2022

Abstract. *In the presented scientific article, the problem of impact with an asymmetric wedge on infinite elastic thread is considered. It is assumed that after the impact, the bent parts of the string fall into the groove, and the slippage of the top of the groove is not taken into account. Depending on the speed of the bent part of the thread and the speed of the groove, the movement mode can be larger or smaller than the sound speed.*

Keywords. wedge · break · flexible · thread · transverse impact · normal impact · supersonic · subsonic.

Mathematics Subject Classification (2010): 74M20

1 Introduction

Let an asymmetrical wedge strike at a constant speed on an elastic thread (Fig. 1). The scheme is adopted with complete bending of the bent part OA and OA1 (Fig.1) of the thread to the cheek of the wedge and the condition of the absence of the thread slipping relative to the wedge at the point O. In dependence from the values of the angles γ_1, γ_2 at a given impact speed, points A and A_1 can move at supersonic speed (under the conditions $Vctg\gamma_1 > Vctg\gamma_2 > a_0$of either one of them with supersonic speed at $Vctg\gamma_2 > a_0$ and the other with subsonic speed at $Vctg\gamma_1 < a_0$. A subsonic motion mode is also possible in each of the areas OAB_1 and OA_1B_1) (Fig. 2). First, consider the case when $Vctg\gamma_1 > a_0$, $Vctg\gamma_2 > a_0$, i.e. let us study the case when both breakpoints A and A_1 move with supersonic speeds (Fig. 1). At the same time, at points A and A_1 of the thread, different regime conditions can exist.

Tahir J. Mammadov
Ganja State University, Ganja, Azerbaijan
E-mail: yusifova81@inbox.ru

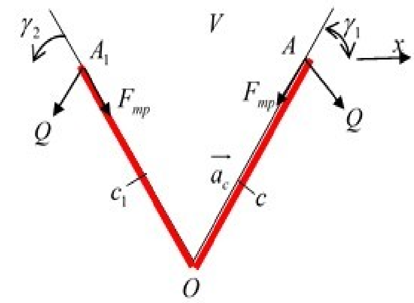

Fig. 1

All solutions (for each of the regions) can be obtained from the solution of the problem of transverse impact by a symmetrical wedge on an elastic thread, in [1]. Only in each case you need to replace the angle γ through γ_1 and γ_2 respectively.

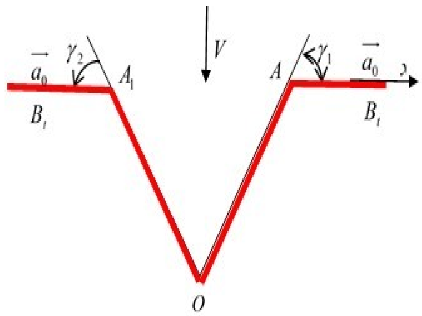

Fig. 2

For example, if at point A we have the first mode of motion, and at point A1 the second mode of motion then the solution of the elastic problem in the OA region will be

$$U = x\,\sec\gamma_1;\;\; \varepsilon = \sec\gamma_1 - 1;\;\; v = 0 \tag{1.1}$$

and in the region OA1 we have

$$\begin{cases} \varepsilon = \frac{M^2}{M^2 - tg^2\gamma_2}\sin\gamma_2\left(tg\gamma_{2*} - tg\frac{\gamma_2}{2}\right) \\ v = Mctg\gamma_2\left(\sec\gamma_2 - 1 - \varepsilon\right),\;\; a_0 t \le x < Vtctg\gamma_2 \end{cases} \tag{1.2}$$

$$U = (1 + \varepsilon + v)\,x,\quad 0 \le x \le a_0 t, \tag{1.3}$$

where ε and v are expressed by formulas (1.2).

If at point A it has a regime condition II and at a point A_1 it has a regime condition III then in the OA region the solution is expressed by formulas (1.2), (1.3) when replaced γ_2 by γ_1, and in the region OA_1, we have solutions that have the following form

$$\begin{cases} \varepsilon = \sin\gamma_2\left(tg\gamma_{2*} - tg\frac{\gamma_2}{2}\right) \\ v = M\cos\gamma_2\left(tg\gamma_2 - tg\gamma_{2*}\right);\quad a_0 t \le x < Vtctg\gamma_2 \end{cases} \tag{1.4}$$

$$U = \left[1 + mM\cos\gamma_2\left(tg\gamma_2 - tg\gamma_{2*}\right)\right]x,\quad 0 \le x < \omega t, \tag{1.5}$$

$$m = \frac{\omega}{a_0} = \sqrt{\xi^2 + 1} - \xi,$$

$$\xi = \frac{\sin\gamma_2\,(tg\gamma_2 - tg\gamma_{2*}) - \sec\gamma_2 - 1}{2M\cos\gamma_2\,(tg\gamma_2 - tg\gamma_{2*})}$$

Here $= \frac{V}{a_0}$, V is the impact velocity, 0_0 is the elastic wave velocity, ε is the deformation, v is the velocity of the thread particle, U is the Lagrangian thread particle coordinate. Thus, on one cheek of the wedge, the thread may be stretched, and on the other - wrinkled behind a strong break wave (Fig. 3)

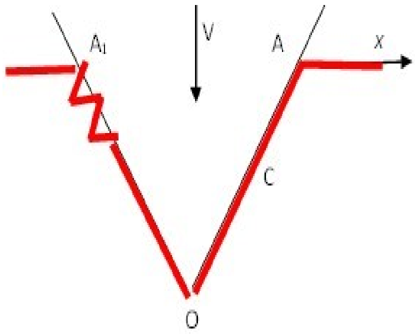

Fig. 3

Finally, the case is possible when both points A and A_1 move with subsonic speed. It is obvious that this is possible under the conditions $Vctg\gamma_2 < Vctg\gamma_1 < a_0$. And in this case, all possible solutions are obtained from the solutions of the problems considered earlier, conscientiously, when replacing $\gamma = \gamma_2$ (in the region OA_1B_1) and $\gamma = \gamma_1$ in the region OAB_1 (Fig. 3)

The problem of breaking a thread upon impact with an asymmetric wedge is solved as follows. After finding the solution in the area OA and OA1 (in the supersonic and subsonic regimes), the critical failure stresses are determined at the point $x = 0$. Then the problem must be solved with a break similar to those considered earlier.

References

1. Mutallimov SH.M. Normalnyy udar prituplennym telom po gibkoj svyazi. V sb. IMM AN Azerbaydzhana "Mekhanika deformiruemyh tverdyh tel", vyp. 1, 1970, s. 42- 49. (in Russian)
2. Mutallimov SH.M. Normalnyj udar zhestkim klinom po gibkoj uprugoj neodnorodnoj niti. V sb. "Nekotorye voprosy matematicheskogo modelirovaniya". B., 1988. s. 180-188. (in Russian)
3. Mutallimov SH.M. Normalnyj udar klinom po uprugoplasticheskoj niti pri dozvukovom rezhime dvizheniya "Prikladnaya mekhanika". Kiev, 1993, t. 29, ¹6, s.64-69. (in Russian)
4. Mutallimov K.SH. Normalnyj udar klinom po gibkoj niti pri nalichii treniya s uchetom obryva. Dep. AzNIINTI, 2356 – Az, 1996, s. 6. (in Russian)
5. Mamedov T.Dzh. Normalnyj udar klinom po vyazkouprugoj niti s uchetom ee razrusheniya (dozvukovoj rezhim) Vestnik Bakinskogo Universiteta, seriya fiziko-matematicheskih nauk, Baku 2015, ¹ 3 str. 117 – 127. (in Russian)
6. Ryabis A.A. Poperechnyj udar prituplennym telom po gibkoj svyazi pri nalichii treniya. Vestnik MGU, ser. Matem. Nauk, 1966, ¹6, s. 71 – 79. (in Russian)