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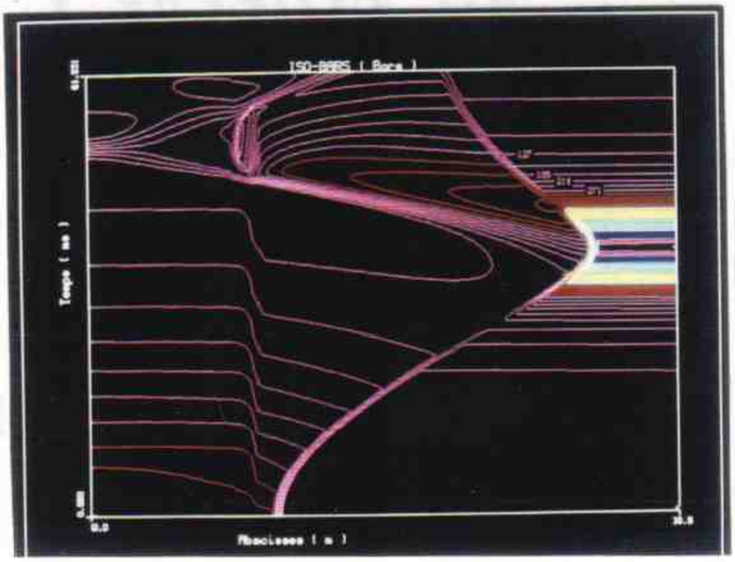

BOOK OF ABSTRACTS

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COMPARATIVE EFFICIENCY OF SHOCK WAVE ATTENUATION IN CHANNELS BY VARIOUS MEANS

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For preventing severe shock loading of consrtruction elements in many practical applications various shock quenchers are used. One can classify the quenchers by governing mechanisms of shock attenuation. There are at least three distinct mechanisms of shock attenuation in channels:

- momentum losses due to channel area expansion;
- momentum losses associated with drag at quencher elements;
- momentum losses due to mass outflow through wall perforations

In general, realistic shock quenchers involve a few of the mechanisms. There is an urgent need in elaboration of theoretical approaches for estimating quencher efficiency and optimizing quencher configuration in view of actual technological restrictions. This study was undertaken to develop such an approach.

Analysis of shock wave attenuation in channels with quenching means of various types has been carried out on the basis of Whitham's idea. Let M_i and M are respectively the shock wave Mach number upstream and downstream a quencher, X the dimensionless length of the quencher, G the characteristic function of the shock wave Mach number. Then the approximate solutions for the three above mentioned mechanisms of shock attenuation in air have the form:

(e) area expansion (Gvozdeva et al): $G_e(M)/G_e(M_i) - 1 = X$, with

$G_e(M) \approx 1.58[(M^2 - 1)^2(M^2 + 1/4)^{1/2}]^{-1}$;

(d) drag (Frolov et al): $G_d(M_i) - G_d(M) = X$, with

$G_d(M) = 4(0.4M - 1)/(M^2 - 1) + 4\ln(M^2 - 1) + 0.8\ln(M + 1)/(M - 1)$;

(m) mass outflow (Frolov et al): $G_m(M_i) - G_m(M) = X$, with

$G_m(M) \approx 4.3(M^{1.2} - 1.012)^{0.8}$

Presented in Table are the formulae for determining X for realistic quenching means. All above approximations have been compared with numerous available experimental data and satisfactory agreement has been pointed out.

Similarity of the approximations allows direct comparison of shock quenching efficiencies. The efficiency is defined as the ratio $(M_i - M)/M_i$ attained at a given X. Figure shows a nomogram for optimizing quencher configuration.

There are three families of curves, (e), (d), and (m), corresponding with the above mechanisms. The curves are plotted for four values of M_i, namely, 1.5, 2, 3, 4. Intersection points of the curves at M_i = idem are the points of equivalent quenching efficiency. A locus of such points is the line of equivalent quenching efficiency.

Three thick lines separate the M-X plane into 6 characteristic domains. In domain I efficiency of mechanism (m) is larger than that of mechanism (e), while the latter is larger than that of mechanism (d). Such a relation can be written in the form: (I) $d < e < m$. In other domains: (II) $e < d < m$, (III) $e < m < d$, (IV) $m < e < d$, (V) $m < d < e$, (VI) $d < m < e$.

Optimum quencher configuration corresponds with the case when a specified shock attenuation is attained at a minimum distance X. If an actual distance is specified then system distortion by a quencher appears to be minimum. In addition to numerous applications, some considerations concerning attenuating the pressure behind a leading shock are also discussed.

Table. Dimensionless length for various shock quenching means

Means	X
area expansion	$(dA/dx)(x/A_0)$
wall perforation	$(\omega\Pi/2A)\varepsilon x$
regular obstacles	$(\Pi/2A)\lambda x$
beds of granular solids	$1.75(1 - \varepsilon)(x/\varepsilon d_p)$
perforated partitions	$26(\varepsilon^{-0.1} - 1)$

Notations: x actual distance; A, A_0 channel cross section area; Π channel perimeter; ω perforated part of channel perimeter; ε perforation ratio, porosity; λ hydraulic drag; d_p particle size.

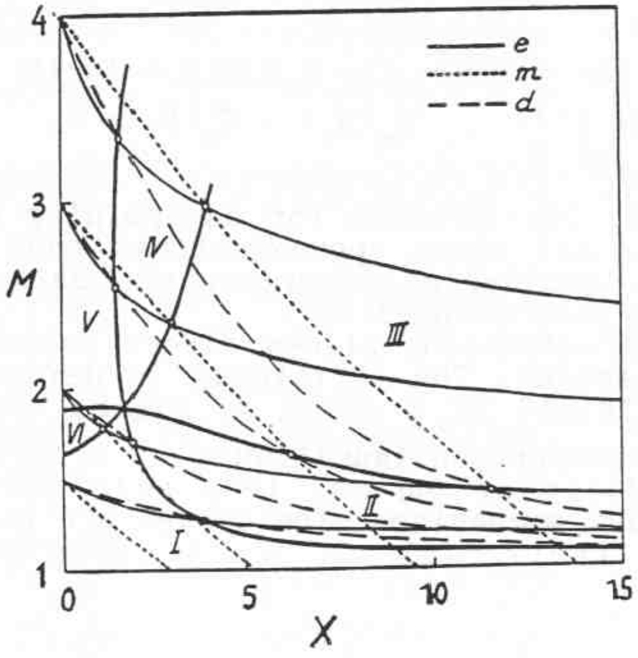

Fig. A nomogram for optimizing shock quenching means