

Numerical Simulation on the Interaction between Shaped Charge Jets and Confined Explosives

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Abstract. By applying dynamic software 3D LS-DYNA, The shaped charge jet and its penetration into confined explosives is simulated. The simulation results show that: in normal impact, the shaped charge jet disturbed by denotation product which decreased the jet penetration, and in oblique interaction, the shaped charge jet cut by moving plate beside disturbed by denotation product. The effect increase with jet entry angle.

Introduction

The flat surface mezzanine packs target structure of medicine to clip a thin layer between two pieces of lamellas explosive, explosive explosion, drive metal target plank to follow method to fly to spread, the strong interference gathers ability metal shoot to flow or wear A pole body and make of expiration or lower to invade steeping ability. BE considering towards shooting and flowing to bump shot flat surface mezzanine to pack a medicine research winning, generally that shooting to flow is inclined the mezzanine invading steeping flat surface packs a medicine and fly plank with shoot to flow a direct function mutually, strengthened interference effect. When shoot to flow perpendicularity to bump shot and wear deeply lamella at the same time, the explosive drives metal plank to follow method to exercise, in order to flying plank sport direction and shooting to flow a direction parallelism, in the process of exercising in shoot to flow and fly plank don't get in touch with, mainly is an explosion field to have a miscarriage to living a function towards shooting.

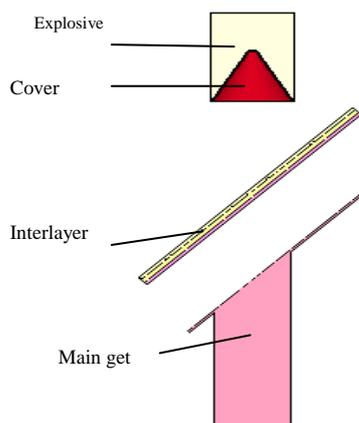


Figure 1. Shoot to flow to invade sloping flat surface mezzanine to pack medicine model.

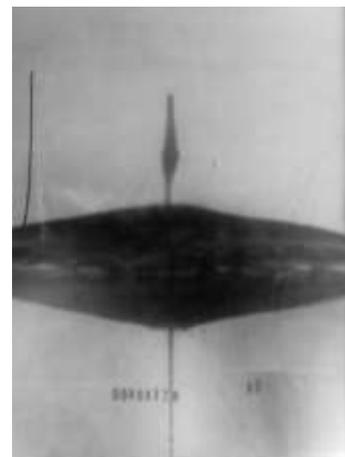


Figure 2. X-ray that the flat panel transforms lightings.

The formation that this literary grace is shot to flow with the 3D limited dollar procedure emulation and invade Steeping process to the Target knothole that puts to have flat surface mezzanine the explosive, the aim forms after analytical explosive explosion of the outcome fly to is over and throw to shoot to accelerate the front-panel is to the influence that shoots to flow to invade Steeping ability.

Model and Material Parameter

Gathering can pack a medicine to shoot to flow is metal medicine type cover to shut Su metal of matching the creation to flow to the central axis line while exploding an outcome function, it has higher head speed, keep both in the certain speed gradient, shoot to flow the side sport side to pull to stretch. Shoot to flow moreover is a high-speed collision process with the Target knothole interaction process, invade Steeping in will appear big contingency, greatly transform and high contingency rate phenomenon, adopt a pure Lagrangian calculate way very difficult realization to shoot to flow formation and pull to stretch and invade the number emulation of Steeping process in the middle of the LS-DYNA procedure. According to the above consideration, model all materials models for involving all adopt Eulerian calculate way, then adopt many material ALE calculate ways of LS-DYNA procedure.

In order to adopting ALE calculate way, have to promise each material model boundary noodles total node. The whole model includes a lord to pack a medicine, medicine type the cover, the lord Target plank, mezzanine explosive (front-panel, explosive and target ck plank) constitute, such as figure 1 is shoot to flow inclined invade Steeping to take mezzanine to pack the medicine number calculation model of sketch map.

Compute model to pack the medicine diameter 56 mms, after the cover medicine pillar high 31 mms, medicine form cover is red copper, the department diameter 54 mms, cover a thick 1 mm, deep-fried Gao 80 mms. Medicine form while computing the cover and Target plank all adopt Johnson-Cook model and GRUNEISEN status equation common description, the model can describe to meet an emergency with material, the contingency lead and temperature related strength variety, medicine form cover and Target knothole main parameter such as table 1 show.

Table 1. Targetsic parameter.

parameter	ρ/gcm^{-3}	E/GPa	μ	A/MPa	B/MPa	C	n	m
cover	8.96	124	0.34	100	300	0.025	0.31	1.09
target plank	7.8	210	0.22	792	180	0.016	0.12	1

The lord packs the medicine adoption JWL status equation and explode the pressure of bombing the outcome for[4]:

$$P = A_{JWL} \left(1 - \frac{\omega\eta}{R_1}\right) e^{\frac{R_1}{\eta}} + B_{JWL} \left(1 - \frac{\omega\eta}{R_2}\right) e^{\frac{R_2}{\eta}} + \omega\eta\rho_r e \quad (1)$$

Among them: $\eta = \rho/\rho_r$, ρ is the explode to bomb outcome density, the ρ_r is an explosive density, e is inside ability, A_{JWL} , B_{JWL} , R_1 , R_2 , ω is the material characteristic of the explosive parameter, its value sees table 2.

Table 2. Explosive material targetsic parameter

parameter	ρ/gcm^{-3}	A_{JWL}/MPa	B_{JWL}/MPa	R_1	R_2	ω	D/ms^{-1}
explosive	1.72	3.74×10^5	3300	4.5	0.95	0.3	8930

The mezzanine packs the medicine as the for use by the military B explosive and adopts to play ductility model(ELASTIC_PLASTIC_HYDRO) and light fire and growth status equation(IGNITION_GROWTH_OF_REACTION_IN_HE) come common description, the material parameter involved such as table 3 show. The physical meaning of parameter in form is as follows: The I is very hot for control point quantity parameter; G1 and G2 differences has something to do with explosive grain's getting in touch with status for the reactions in hot point earlier period increasing after the control point fires and under the high pressure of reaction speed.

The an is a critical compression degree, use to limit to light fire boundary, be a compression degree is smaller than a the explosive won't light fire; B, the c is to respond the related parameter of the position of biggest speed; D, g is hot point growth shape relevant parameter; In order to burn the non-layer of reaction to flow characteristic relevant parameter y and z, it takes to be worth scope general 0.8~2.0 of, λ_{igmax} , the λ_{G1max} is worth for lighting fire and combustion reaction degree biggest respectively; The λ_{G2min} reaction degree is smallest worth, ρ_0 is an explosive density, PCJ explodes to bomb pressure for C-J; D for explode to bomb speed.

For the sake of comparison flat surface mezzanine the explosive fly to is over to the influence and relationship with angle of incidence degree that shoots to flow to invade Steeping ability and computed to shoot to flow a rightness not to put the main Target of mezzanine explosive to invade Steeping first, then, computed respectively 0° , 45° and 68° three kinds of circumstances under shoot to flow to invade Steeping process to the Target knothole that places mezzanine explosive.

Table 3. Blighting explosive growth model material parameter.

parameter	P_C/GPa	ρ_0/gcm^{-3}	$I/\mu\text{s}^{-1}$	$G_1/\mu\text{sGPa}^{-1}$	a	c	y	λ_{G2min}
The B explosive parameter	27	1.72	4.4×10^{11}	310	0	0.667	1.0	0
parameter	λ_{igmax}	λ_{G1max}	$D/\text{cm}\mu\text{s}^{-1}$	$G_2/\mu\text{sGPa}^{-1}$	b	d	z	g
The B explosive	0.3	0.5	6930	4.0×10^4	0.667	0.111	2.0	1.0

The Number Imitates Result and Analysis

Number Emulation with Experiment Result Comparison

Experiment and adopt a 56 mm standard and gather to invade a Steeping body, originally experiment and adopt a 450 kvs two set pulse X-ray machine combinations and carry on taking, two set pulse X-ray shoot a line tube the cloth establish into 45 degrees and remit and hand over, gathering can invade a Steeping body the cloth establish in perpendicular way, and promise to take shape behind gather can invade a Steeping body and shoot line tube and remit and hand over stalk through two set Xs. Pass to establish a different of two pulse X-ray machines light time, such an experiment and then can get two different time of X-ray photograph. The flat surface mezzanine packs a medicine to fly plank sport with transform of X-ray photograph such as figure 2 show, with figure 3 medium the number model get of the flat panel transform target sic consistent. The experiment gets the extreme limit speed of flat panel as 933 ms|s. The number emulation gets of produce plank extreme limit speed is 1040 ms|s, compare an experiment slightly greatly, error margin at 10% in, explain number to imitate process target sic exactitude. For the sake of comparison the flat surface mezzanine explosive structure the explosion is behind to the influence and relationship with angle of incidence degree that shoots to flow to invade Steeping ability, this text computed perpendicular invade Steeping and 45° inclined invade Steeping three kinds of circumstances.

Shoot to Flow Perpendicularity to Invade Steeping to Put to Have the Flat Surface Mezzanine the Target Plank of the Explosive

Figure 3 is shoot to flow perpendicularity to invade Steeping to put to have the Target knothole number that the flat surface mezzanine packs a medicine to imitate a result. Could see from the result diagram, shot to flow to invade Steeping to set off mezzanine to pack a medicine, explosive is after exploding explode to bomb an outcome push front-panel and target plank mutually to exercise. Because the noodles, target plank sport direction runs parallel with shooting inflow to shoot a direction, in the process of exercising in, front-panel and target plank are very small to the influence that shoots to flow. But explode to bomb the outcome flows to exercise to produce a certain perturb target towards shooting and lowered to shoot to flow thus to lord invading of Target Steeping ability.

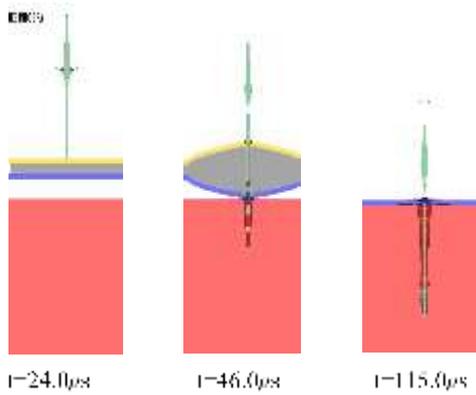


Figure 3. Shoot to flow perpendicularity to invade the Steeping flat surface mezzanine explosive physical diagram 1.

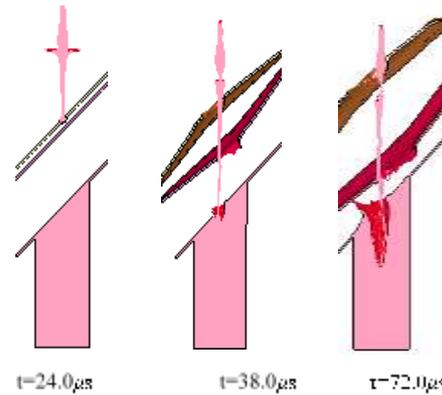


Figure 4. Shoot to flow 45° inclined invade a Steeping dissimilarity time of physical state graph.

With have no the calculation model of reaction type armor to compare, the flat surface mezzanine explosive structure makes to shoot to flow to lord the invading of Target Steeping depth descend for the 101 mms and invaded Steeping ability to let up 45%.It is thus clear that, while shooting to flow perpendicularity to invade Steeping mezzanine explosive, explode to bomb outcome to flow to have an obvious perturtargettion effect towards shooting.

Shoot to Flow 45° Inclined the Mezzanine Invading Steeping Flat Surface Pack Medicine Structure

Figure 4 is gather can shoot to flow 45° inclined the number of explosive and lord Target invading Steeping mezzanine imitate a result. With shoot to flow perpendicularity to invade Steeping different BE, be after shooting to flow to set off mezzanine explosive, explode to bomb an outcome push front-panel to outwardly exercise. Because the front-panel is in the process of exercising in with shoot to flow an occurrence collision function, shoot to flow BE "incise" a function by front-panel, make to shoot run off now teeth of a saw form, and deviate a beginning to start to invade a Steeping direction occurrence flection. This kind of function makes to shoot to flow much easier than occurrence to split, thus and consumedly lowering to shoot to flow the Steeping ability is to the invading of lord Target.

Two Kinds of Angle of Incidences Degree Computes Result Contrast

Under the above two kinds of angle of incidences degree circumstance, difference various circumstance to lord the Target invade Steeping depth with it to should of have no the flat surface mezzanine pack an invading of medicine structure Steeping ability comparison, figure 6 shot to once circulate flat surface mezzanine to pack a medicine to invade Steeping ability to descend curve for three kinds of circumstances, from figure 6 can see, along with the increment of the angle of incidence degree, to lord invading of Target Steeping ability's lowering range have already enlarged trend. Invade Steeping ability to descend 50.4% while being perpendicular to invade Steeping, 45° invades Steeping to decline 87.6% at present.

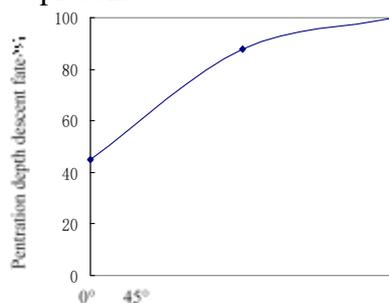


Figure 5. Shoot to flow to invade Steeping result contrast compare diagram.

Conclusions

The flat surface mezzanine mainly is what the incising of perturbation and front-panel effect of outcome arouses to the interference that shoots to flow after packing a medicine explosion. Invade Steeping to the perpendicularity, shoot to flow mainly is exploded the influence of bombing the outcome, is shooting to flow inner part to form a series of perturbation, made to shoot to flow much easier than the ability for split, invading Steeping descend. Shoot to flow for the inclined circumstance for invading Steeping in addition to being exploded the influence of bombing the outcome, most is be subjected to front-panel of "incise" a function, make to shoot run off now teeth of a saw form and take place bent, in the process of pulling to stretch further in appear splitting of severity, lowered to shoot to flow thus of invade Steeping ability. Along with shoot to flow Target angle of increment, front-panel to shoot to flow of "incise" function influence to immediately strengthen to add, take place to deflect, flexion and the number increment for splitting, invade Steeping ability also immediately significant lower.

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