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The Study Effect of Density in Sea Water by the Motion of Cylindrical Shock Wave

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ABSTRACT: The propagation of shock wave in deep sea, have been investigating the effect of density of sea under water Earthquake to analyze 'Tsunami' for two cases i.e. diverging and conversing Cylindrical shock wave and summarize shock strength different shock parameters and depend on direction.

I. INTRODUCTION

The shock wave propagation in sea water has been studied by Bhatnagar at., al; Rao Ranga & Ramana (1973) Singh at., al (1980) without taking the effect of earth gravitating atmosphere and all direction since Yadav & Kumar (1970) in the troposphere. Investigation in this paper the propagation of cylindrical shock wave under sea water medium depends on the density of water. Thus the water medium is non-uniform although the change in presence of density in all direction. Propagation cylindrical shock wave in under sea water diverging and converging the shock strength and density change in all direction. Using different techniques many authors have been study the propagation of shock waves in uniform and non-uniform medium. Yadav and Singh(2004) have studied of strong cylindrical and cylindrical shock wave in the non- uniform medium father effect of overtaking disturbances Yadav (1992).the variation of shock velocity, particle velocity, pressure and density in all direction.

II. BASIC EQUATION

The basic equations for the flow behind the shock front in sea water-

$$\frac{\partial p}{\partial t}+\frac{\partial}{\partial r}(\rho u)+\frac{1}{r}\frac{\partial}{\partial \theta}(\rho \mathrm{v})+\frac{\alpha \rho u}{r}+\rho \mathrm{v}\frac{\cot\theta}{r}=0 \tag{1}$$

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial r}+\frac{\mathrm{v}}{r}\frac{\partial u}{\partial \theta}+\frac{1}{\rho}\frac{\partial p}{\partial r}=0 \tag{2}$$

$$\frac{\partial \mathrm{v}}{\partial t}+u\frac{\partial \mathrm{v}}{\partial r}+\frac{\mathrm{v}}{r}\frac{\partial \mathrm{v}}{\partial \theta}+\frac{1}{\rho r}\frac{\partial p}{\partial \theta}=0 \tag{3}$$

Where, r is propagation distance u, v, p U and are respectively the particle velocity in redial direction, velocity in transverse direction, the pressure, the shock velocity and $\alpha=1$ or 2 respectively for the cylindrical or spherical flow.

III. BOUNDRY CONDITIONS

If p_0 and ρ_0 denoted the undisturbed value of pressure and density in front of shock wave the jump condition are

$$u=\frac{2a_0 M}{(n+1)},\qquad p=\frac{2a_0^2 M^2\rho_0}{(n+1)},\qquad \rho=\rho_0\frac{(n+1)}{(n-1)}$$

$$s = \sqrt{\frac{2n}{n+1}}$$

$$\rho = SMa_0 \left(\frac{n-1}{n+1}\right) \qquad (4)$$

THEORY FOR DIVERGING SHOCK WAVES

In the freely propagation description, the characterstics form of system of equation (1)-(3) i.e. the form in which each equation contains derivatives in only direction in the (r, t) plane.

$$dp + \rho a du + \frac{\rho a^2}{(u+a)}\left(\frac{\alpha u}{r} + \frac{v}{r}\cot\theta\right)dr = 0 \qquad \textbf{(5)}$$

Equations (5) represent the characteristic form of diverging shock wave.

Now using jump conditions in equation (5), we get –

$$M^2 \frac{d\rho_0}{\rho_0} + (1+\frac{s}{2})dM^2 + \frac{s^2 M^2 (n-1)(\alpha + \cot\theta)}{[2+s(n-1)]}\frac{dr}{r} = 0$$

Where , $\rho_0 = \rho^1(1+xr)$

x = Arbitrary constt.

$$\frac{dM^2}{M^2} + \frac{2}{(2+s)}\frac{xdr}{(1+xr)} + \frac{2}{(2+s)}\frac{s^2(n-1)(\alpha+\cot\theta)}{[2+s(n-1)]}\frac{dr}{r} = 0$$

Let $Q = \frac{2}{(2+s)}\frac{s^2(n-1)(\alpha+\cot\theta)}{[2+s(n-1)]}$, $\mu = \frac{2}{(2+s)}$

on integrating equation.

SHOCK STRENGTH

$$M_+ = \xi r^{-Q/2}(1+xr)^{-\mu/2} \qquad (6)$$

where ξ is constant of integration

Shock velocity, Particle Velocity and Density expression

$$U = \left[\frac{n\xi}{\rho'(1+xr)}\right]^{1/2} \xi\ r^{-Q/2}\ (1+xr)^{-\mu/2} \qquad (7)$$

$$u = \frac{2}{(n+1)}\left[\frac{n\xi}{\rho'(1+xr)}\right]^{1/2} \xi\ r^{-Q/2}\ (1+xr)^{-\mu/2} \qquad (8)$$

$$P = \frac{2\rho_0}{(n+1)}\left(\frac{n\xi}{\rho'(1+xr)}\right) \xi^2\ r^{-Q}\ (1+xr)^{-\mu} \qquad (9)$$

$$\rho = \rho'\left(\frac{\xi}{M}\right)^{2/\mu} r^{-Q/\mu}\left(\frac{(n+1)}{n-1}\right) \qquad (10)$$

THEORY FOR CONVERGING SHOCK WAVE

In the freely propagation description, the characteristic form of system of equations (1) - (3) i.e. the form in which each equation contains derivatives in only direction in the (r, t) plane is-

$$dp - \rho a du + \frac{\rho a^2}{(u-a)}\left(\frac{au}{r} + \frac{v}{r}\cot\theta\right)dr = 0 \qquad (11)$$

Equations (11) represent the characteristics for using boundary condition in this equation we get –

$$\frac{dM^2}{M^2} + \frac{2}{(2-s)}\frac{xdr}{(1+xr)} + \frac{2}{(2-s)}\frac{s^2(n-1)(\alpha+\cot\theta)}{[2-s(n-1)]}\frac{dr}{r} = 0$$

Let $K = \frac{2}{(2-s)}\frac{s^2(n-1)(\alpha+\cot\theta)}{[2-s(n-1)]}$

Let $K = \frac{2}{(2-s)}\frac{s^2(n-1)(\alpha+\cot\theta)}{[2-s(n-1)]}$, $L = \frac{2}{(2-s)}$

SHOCK STRENGTH

$$M\_ = cr^{-k/2}(1+xr)^{-L/2} \qquad (12)$$

Shock velocity, Particle Velocity and Density expression

$$U = \left[\frac{n\xi}{\rho'(1+xr)}\right]^{1/2} \xi\ r^{-K/2}\ (1+xr)^{-L/2} \qquad (13)$$

$$u = \frac{2}{(n+1)}\left[\frac{n\xi}{\rho'(1+xr)}\right]^{1/2} \xi\ r^{-K/2}\ (1+xr)^{-L/2} \qquad (14)$$

$$P = \frac{2\rho_0}{(n+1)}\left(\frac{n\xi}{\rho'(1+xr)}\right) \xi^2\ r^{-K}\ (1+xr)^{-L} \qquad (15)$$

$$\rho = \rho'\left(\frac{\xi}{M}\right)^{2/\mu} r^{-K/L}\left(\frac{(n+1)}{n-1}\right) \qquad (16)$$

IV. RESULT AND DISCUSSION

a. The variation of shock strength for diverging cylindrical shock wave

Initially, taking M=7 at r = 9 and n = 7.5, the variation of shock strength with propagation distance r, parameter n and angle cot θ are given in tables (1-3)

The shock strength decrease with propagation distance (r) as shown in table (1). Shock strength decreases with parameter (n) as shown in table (2). Shock strength also increases with shock front angle (θ) as shown in table (3). Shock velocity, Particle Velocity, Pressure decreases and density increases with distance ® representing Table-1. Particle Velocity, Pressure and Density decreases and Shock velocity increases with parameter (n) representing Table-2. Shock velocity, Particle Velocity, Pressure increases and density unaffected with shock angle (θ) in Table -3.

R	M	U	u	p	□
8.2	7.627611	163.5699	38.48705	69273.74	14.38985
8.4	7.460091	159.9776	37.64178	67733.66	14.70892
8.6	7.299965	156.5437	36.83382	66264.07	15.028
8.8	7.146748	153.2581	36.06073	64860.16	15.34708
9.0	7.000000	150.1112	35.32027	63517.57	15.66615

Table No. -1

n	M	U	u	P	ρ
7.5	7.000000	150.1112	35.32027	63517.57	15.66615
8.5	6.709568	153.1752	32.2474	59175.22	15.17467
9.5	6.486063	156.5407	29.81728	55918.07	14.79882
10.5	6.392638	158.294	28.78072	54578.67	14.64222
11.5	6.165162	163.711	26.19375	51372.69	14.2619

Table No. -2

cot□	M	U	u	P	P
1.192	6.105571	130.9306	30.8072	48322.6	15.66615
1.15	6.290915	134.9052	31.74241	51300.96	15.66615
1.11	6.472662	138.8027	32.65946	54307.99	15.66615
1.072	6.650183	142.6095	33.55519	57327.77	15.66615
1.036	6.82285	146.3123	34.42642	60343.36	15.66615

Table No. -3

b. The variation of shock strength for converging cylindrical shock wave

The shock strength increases with propagation distance (r) as shown in table (4). Shock strength decreases with parameter (n) as shown in table (5). Shock strength also increases with shock front angle (θ) as shown in table (6).
The variation Shock Velocity, Particle Velocity pressure and density with different parameters shown in table below.

r	M	U	u	p	□
7.6	3.685587	0.592889	0.139503	0.849597	13.43262
7.8	4.068247	0.654447	0.153987	1.059766	13.75169
8.0	4.479048	0.720531	0.169537	1.314402	14.07077
8.2	4.919248	0.791344	0.186199	1.621409	14.38985
8.4	5.390129	0.867094	0.204022	1.989841	14.70892

Table No. -4

n	M	U	u	P	ρ
7.2	10.10198	1.809421	0.441322	9.566476	15.84452
7.4	9.364366	1.70044	0.404867	8.247644	15.72375
7.6	8.740552	1.608469	0.374062	7.207979	15.6103
7.8	8.207671	1.530151	0.347762	6.374887	15.50353
8.0	7.748373	1.462926	0.325095	5.697564	15.40286

Table No. -5

cot□	M	U	u	P	P
1.192	26.78029	4.895678	1.151924	67.56063	15.66615
1.150	21.11741	3.860452	0.908342	42.00918	15.66615
1.110	16.84143	3.078765	0.724415	26.71905	15.66615
1.072	13.58409	2.483293	0.584304	17.38297	15.66615
1.036	11.08141	2.025781	0.476654	11.56786	15.66615

Table No. -6

V. CONCLUSION

From this analysis it is concluded that the variation of strength of Tsunami depends on parameters and angle θ therefore damage due to Tsunami is different in different directions. Futher this analysis need to improve with the consideration of the effect of overtaking disturbances.

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