A Study of Shock Resistant of Underwater External Covered Pipeline

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ABSTRACT

In many engineering situation concerning off shore structures of a great importance (pipelines, underwater tunnel crossings in oil industry), their resistance against the load produced by underwater explosions is an important component of the entire structure’s safety. This thesis is related to the analyses of an underwater pipeline protected by an external covered concrete subjected to an explosion close to the external protective structure. At first, the nonlinear dynamic response of a cylinder subjected to a side-on, far-field underwater explosion was studied using the finite-element computer code ABAQUS/USA in this paper. This study showed the numerical results compared with Kwon et al. [13] experimental data. And then, this paper studied the safety assessment of submerged pipelines, exposed to underwater shock. Four cases of pipeline configurations developed by Gong et al. [16] were modeled and simulated. The first case is a submerged empty pipeline without any cover, the second case is a submerged empty pipeline with concrete cover, the third case is an empty pipeline buried in sand and the fouth case deals with a fluid-filled pipeline buried in sand. The numerical results obtained for four pipeline configuration were compared and discussed in order to find the best protection.

Keywords : Pipeline、Underwater explosion、Shock resistant、Protective

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REFERENCES

[1] Huang, H.,“Transient Interaction of Plane Acoustic Waves with a Spherical Elastic Shell,”J. coust.Soc.Am., 45(3), 661-670(1968).

[2] Winker, K., and Nordseewerke, T.,“Trends in the design of conventional submarines,”RINA Symposium on Navel Submarines, Paper No.7(1983).

[3] Fox,P.K.,Kwon,Y.W.,and Shin,Y.S.,1992,“Nonlinear Response of Cylindrical Shells to Underwater Explosion:Testings and Numerical Prediction Using USA/DYNA3D,”Report NPS-ME- 92-002, Naval Postgraduate School, Monterey, CA, March.

[4] 許國強，“壓力殼承受震波動態之研究”，CCIT-INA-S-MS-Tech.Rept.-83-02中正理工學院兵器工程研究所碩士學位論文(1994)。

[5] 梁卓中、王琴生、鄧作樑、賴文豪、林志成，“考慮結構-流體耦合效應之潛艦壓力殼評估(I)”，國推會研究計畫成果報告NSC-85-2623-D0014-016(1996)。

[6] R. W. McCoy and C. T.Sun“Fluid-structrue interaction analysis of a thick-section composite cylinder subjected to underwater blast loading”Composite Structures, Vol.37, No.1,pp.45-55(1997).

[7] 戴毓修，“載具結構及裝備抗震強度之研究”，中正理工學院國防科學研究所博士學位論文(2000)。

[8] 李雅榮、俞君俠，“夾心板結構挫曲強度之探討”，中國機械工程學刊，第七卷第一期，pp.41-51(1986)。

[9] Ross, C.T.F.,“A Novel Submarine Pressure Hull Design,”J.Ship.Res.,Vol.31,pp.186-188(1987).

[10] Jame, J.G. and L.L. Lisa,“Submersible Pressure Hull Design Parametrics,”SNAME Trans., Vol.99,pp.119-146 (1991).

[11] Kwon,Y.W. and Fox,P.K.,“Underwater Shock Response of A Cylinder Subject to A Side-on Explosion”,Computer&Structure Vol.48, No.4,pp.637-646 (1993).

[12] 梁卓中、賴文豪，“考慮流固藕合效應之潛艦壓力殼強度評估之研究”，中正理工學院國防科學研究所博士學位論文(1998)。

[13] Cichocki,K.“Effects of underwater blast loading on structures with protective elements.”International Journal of Impact Engineering 22(1999) 609-617.

[14] Gong, S., W., Lam, K., Y., Lu, C.“Structural analysis of a submarine pipeline subjected to underwater shock”, Int J of Pressure Vessels and

Piping, 77, pp.417-423(2000).
[15] 梁卓中、夏曉文、任展勇、陳弘文，“深潛多球加勁型壓力殼結構最佳化設計之探討”，中國造船暨輪機工程學刊，第二十二卷，pp.159-172(2003)。
[16] 梁卓中、夏曉文、任展勇、陳弘文，“傳統圓筒加進型壓力殼與多球型加勁壓力殼結構強度比較之研究”中國造船暨輪機工程學刊，第二十三卷第三期，pp.125-141(2004)。
[17] 李雅榮、許家豪，“潛艦結構強度分析”台灣大學造船及海洋工程研究所(2004).
[18] C.C.Liang, Hsu, C.Y., Shiah,S.W. and Jen,C.Y.,“A study of stress concentration effect around penetration on curved shell and failure modes for deep-diving submersible vehicle”, Ocean Engineering 32 pp.1098-1121 (2005).
[19] 戴毓修、毛世威、徐慶瑜“加勁平板承受水下爆炸之動態反應分析”中國造船暨輪機工程學刊，第二十五卷第一期，pp.35-46(2006)。
[20] 愛發股份有限公司編著“ABAQUS 實務入門引導”p10-29~10-48.
[21] ABAQUS User’s Manual.
[22] Geer, T.L.“Doubly Asymptotic Approximatioms for Transient Motion of Submerged Structures” J. Acoust. Soc. Am.,64(5),1500-1508(1978).
[23] Cole, R.H., Underwater Explosions, Princeton University Press, Princeton (1948).