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DYNAMIC ANALYSIS OF THE S-TYPE FLUID-CONVEYING STEEL PIPE FOR TSEN-WENG RESERVOIR USING FINITE ELEMENT METHOD

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ABSTRACT

About seven years ago, the first author was invited to attend a meeting held by the "South Water Resources Bureau" to discuss the problem about cleaning sediments of the Jsen-Weng Reservoir located at Tainan, Taiwan. At that time, a suggestion to replace "the conventional sluice gate near free water surface" by "the siphon with its inlet near reservoir bottom" (cf. Figure. A1 in Appendix) was presented and approved by all the attendees. Five years later, about two years ago, the first author was invited again to attend a meeting to review the report for a project about the construction of a tunnel for cleaning sediments of the Jsen-Weng Reservoir. The key point is to review the design of a "S-type water-conveying steel pipe" (or simply called "S-pipe") with its outlet connecting with an 1.2 km tunnel passing through a mountain. The pipe diameter is 10m with maximum draft at its outlet to be $h \approx 35\,m$, so that the S-pipe will be subjected to the impulses $F_L = F_R \approx 5384$ tons at its inlet and outlet, as well as the resultant centrifugal forces $\tilde{F}_{c1} = \tilde{F}_{c2} \approx 3760$ tons at its two curved parts. Because of being non-collinear, each pair of impulses or centrifugal forces will induce an unbalanced "couple" with total magnitude $C_{total} \approx 216727$ m-ton, furthermore, its vibration due to pulsating fluid flow may lead to the liquefaction of soil contacting with it. Since the above-mentioned problems are neglected in the reviewed report, the first objective of this paper is to use the finite element method (FEM) for studying the quasi-static deflections of some points on the S-pipe due to actions of the "constant" impulses at its inlet and outlet as well as the centrifugal forces at the two curved parts when the flowing velocity becomes a "constant" (e.g., $V \approx 24.25$ m/s) from the initial static condition (with $V = 0$). The next objective is to study the dynamic responses of the S-pipe due to "pulsating" flow with velocity $V(t) = V_0(1+ ¢ \cos \mu_e t)$, where V_0 is average velocity, t is time, ¢ is pulsating parameter and μ_e is pulsating frequency. Numerical results reveal that the S-pipe will be safe if it is subjected to the "constant" impulses and centrifugal forces, however, its safety may be questionable if it is subjected to "pulsating" flow. It is believed that the original conception shown in the Appendix of this paper should be a better choice.

KEYWORDS: *Centrifugal Force, Forced Vibration, Free Vibration, Impulse, Pulsating Flow, Soil Liquefaction*

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