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Siphon and Submerge Pipeline, Design and Behaviour using the Reptile Skeleton and Accordion Connection

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Abstract
Submerge pipeline and siphon are time-consuming and costly due to executive problems and due to difficult access to under sea water. Settlements in marshland and ring cracks in the pipe skin are problems leading to pipeline reconstruction. Settlement and non- flexible connection exercise the stress unto the Joints. New design could be defined using the spinal column behaviors and reptile moving. The degree of freedom should be satisfied through two degrees rotation and one degree expansion at joint. Therefore, super flexibility could be obtained using the 3 degree freedom at each connection. Spinal parts must be simulated using the pre-cast concrete section with PE covering and accordion joint should be installed using the steel arms inside the concrete. Accordion behaviors could be obtained using the layers of high- tensile PE with silk string which will guarantee the water proofing. In the workshop reptile spinal pipeline could be made by a series of production line of concrete sections, fabrication yard and parallel water channel near the production site. More advantages could be obtained through the new design: sewage pipeline are damaged at the joint through sewer exposure and extra rotations and the resulting deflection could be satisfied by the accordion joint.

Keywords
Accordion, Spinal Column, Siphon and Pipeline

1. Introduction

Main water resource of agricultural area in Khoramshahr project provided using siphons with more than 200m length under the Karun River. The very low resistance of the River Bed and tidal flow influenced by the Persian Gulf water create problems in installing siphons. Segmental parts and the freedom connection at each accordion point alleviate the problems of settlement and joint breaking in pipeline. A series of segments should be designed in such a way that they transfer the flow through pipeline section and flexible streamline. Considering the variable segmental pipeline length and required accordion connection in each joint, the streamline may follow the natural River Bed. Therefore, the joint will be designed to modify three degrees of freedom at space movement using the innovated connection, spherical ball and rod slotting part which can satisfy rotation in two directions and release movement in the direction of the streamline for each part. All simulations are invented using the reptile motion on soil when the radius of curvature fits in the small values. Also, vibration equation would be computed on each segment using the radius acceleration, damping resistance or angular momentum and axial stiffness in the direction of the vibration produced by the pipeline curvature and constant discharge of design.

2. Reptile Behaviors

Flexible curve could be produced using the reptile motion on surface. Reptile motion consist a series of segmental circle with curvatures radius. The main part is defined by the joints at each connection, freedom degree of joints and moment release. Figure 1 illustrates reptile characteristics in cinematic deflection and extra rotation at joint.

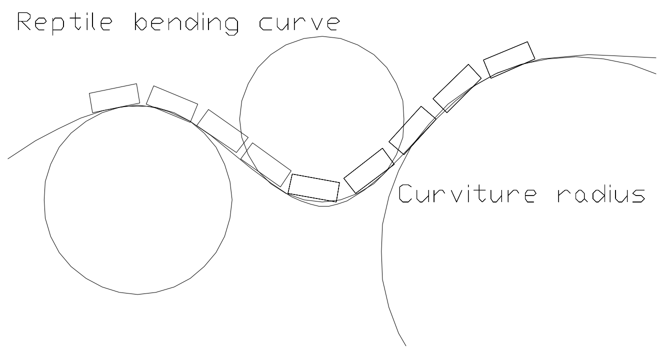

Figure 1: Joints and structural part of reptile modeling

Allowed deflection could be simulated in connection using the new accordion behavior that satisfy the concrete strain and deflection hydraulic head at pipeline engineering. Figures 2 and 3 can interpret tensile and twist tensions simultaneously.

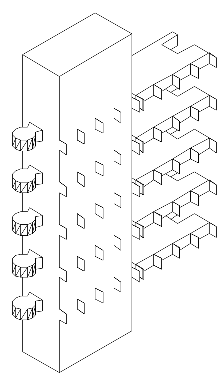

Figure 2: Movable joint and longitudinal displacements

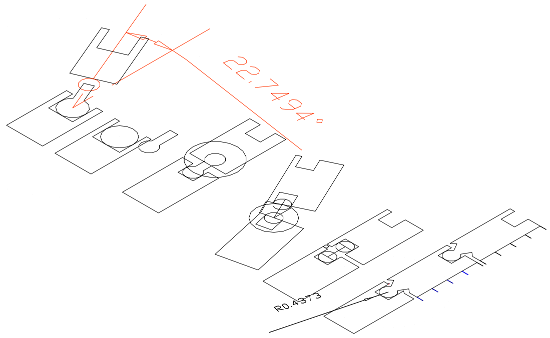

Figure 3: Release turning using the one and two degree freedom at joints.

3. Steel Floating Bridge

The new design is recommended to be used in floating bridges when tidal waves and traffic loads simultaneously exert force upon the bridge. The new design stems from the idea of getting access to the island located in the Karun River by Army Bridge which was to be modified considering the concept of Figure 3 and water level fluctuation. Two degrees of freedom are respectively suggested for release bending moment and axial movement with fixed arm on the right side.

4. Pipeline and Siphons

An S-W project of KWPA main water supply has been designed to be provided by Mared channel using siphons with 200m length and discharges 16 CMS under the Karun River. The River Bed was measured with a hydro graph instruments. The maximum intersection angle at -16.5m depth was more than 20 degrees on the left side of the River bank. Standard curvature should be applied to manufacture products (PE pipe, steel pipe and concrete pipe) and water head deflection. Economic design could be produced using the reptile pipeline and accordion connection with special curvature and natural adaptation that occupy the minimum surface of the River Bed. Also, it can be used in problematic soils, liquefaction area and settlement at bed. Behaviors must follow the spherical knee at joints. The details are explained in Figures 4 and 5.

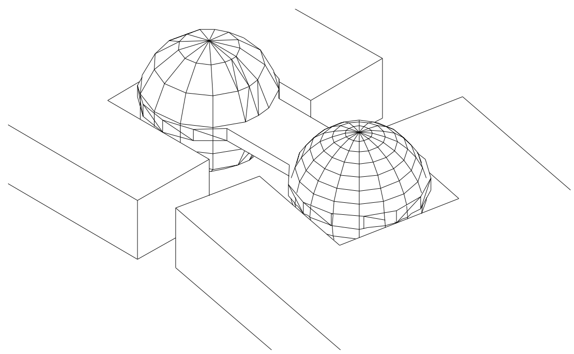

Figure 4: Two direction twist and longitudinal movement.

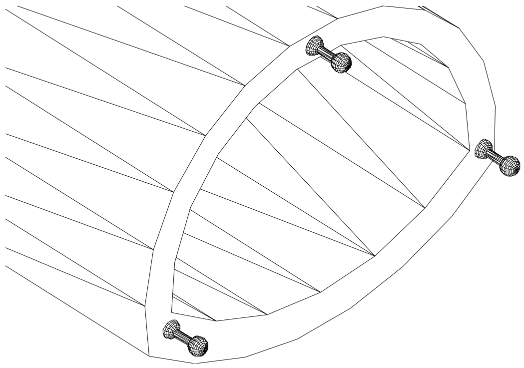

Figure 5: Three pins for static stability and sphere ends in accordion joint.

4.1 Dynamic Equation of Forces

Dynamic fluid exerts extra forces through the internal characteristics of concrete pipeline, soil resistance and geotechnical parameters, constant discharge and radius of curvatures. Equation 1 generates dynamic forces. Constant figures could be interpreted by the natural soil behavior, bed River properties and Figure 6. Constant Figures could be evaluated from river bed condition by a series of variable values.

$$M_i \ddot{U}_{ri} + C_{ri}\dot{U}_{ri} + K_{ri}U_{ri} = \sum F_{ri} \quad (1)$$

$$M_i = Mass\ of\ \ fluid\ (kg)\,;C_{ri} = Damping\left(\tfrac{kg.rad}{s}\right);\,K_{ri} = Axial\ stiffness\left(\tfrac{KN}{m}\right)$$

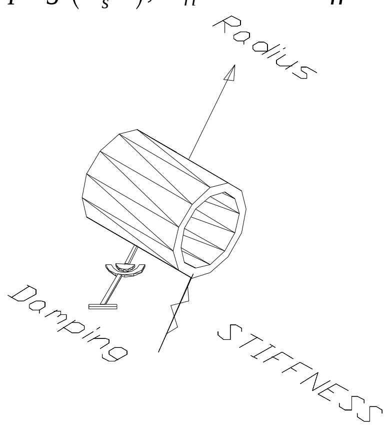

Figure 6: Concrete segmental part and vibration forces by streamline.

4.1.1 Mass influence (M)

M is indicated using the control volume, Figure 6 and Equation 2 (Q=discharge; A= section area).

$$\vec{\upsilon}_i = \frac{Q}{A_i}$$

$$M\ddot{U} = M\,\frac{\left(\frac{Q}{A_i}\right)^2}{R_i} \qquad (2)$$

$$\ddot{U}_i = \frac{\upsilon_i^{\,2}}{R_i}$$

4.1.2 Damping or angular momentum (C)

C in curved lines and small curvatures could be computed by the angular momentum when the force vector is accelerated through the perpendicular direction (r) upon the streamline. Equation 3 explains damping force on the bed line (ω = natural frequency; D= pipe diameter; R= curvature).

$$C_{ri} = M_i.\omega_{ri}$$

$$\omega_{ri} = \sqrt{\frac{K_{ri}}{M_i}}$$

$$C_{ri}.\dot{U}_{ri} = \vec{\upsilon}_{ri}\sqrt{2K_{ri}M_i\,\frac{D_{ri}}{R_i}} \qquad (3)$$

4.1.3 Axial stiffness by Turk method (K)

Spring behavior may be demonstrated by the soil resistance at River Bed (Turk, 2004) and it is recommended that the pipeline be stabilized with grouting. K values will be measured using Equation 4 and 5. These values depend on soil resistance (Turk, 2005) and work conditions.

$$\xi_{X-Y} = \left(\frac{F}{A.\delta}\right)_{grouting} \times \left(\frac{E_{soil}}{E_{grouting}}\right)_{X-Y} \qquad (4)$$

$$K_{ri} = \xi_{X-Y} \times A_{X-Y} \qquad (5)$$

$$\xi_{X-Y} = subgrade\ reaction\ \mathrm{mod}ules\left(\frac{kg}{cm^3}\right);\ F = compressive\ or\ tensile\ pile\ load\ test(kg)$$

$$A = grouting\ Area\ around\ pile\ \left(cm^2\right);\ \delta = plastic\ settlement\ of\ micropile\ (cm)$$

$$E = Elasticity\ \mathrm{mod}ules\ of\ soil\ and\ grouting\ area\left(\frac{kg}{cm^2}\right)$$

$$K_{ri} = axial\ stiffness\ in\ \vec{R}\ direction\left(\frac{kg}{cm}\right);\ A_{X-Y} = horizontal\ plan\ area\ \left(cm^2\right)$$

4.1.4 Safety factor of vibration parts

Problems occur when extra forces and resonance conditions are created. The total force resulting from the control volume weight per concrete segments (Equation 6) should be constrained. Natural force may be computed based on natural bed line condition and soil resistance. To increase safety factor in low resistance soil, the pipeline should be stabilized using the root net grouting at Bed River with local micro pile pins. Plan

$$S.F_{Turk} = \frac{\left(M_i \ddot{U}_{ri} + C_{ri}\dot{U}_{ri} + K_{ri}U_{ri}\right)_{Natural}}{M_i \frac{\left(\frac{Q}{A_I}\right)^2}{R_i} + \vec{\upsilon}_{ri}\sqrt{2K_{ri}M_i \frac{D_{ri}}{R_i}} + \left[\left(\frac{F}{A.\delta}\right)_{grouting} \times \left(\frac{E_{soil}}{E_{grouting}}\right)_{X-Y}\right] \times \left(A_{X-Y}\right).\delta_{plastic}} \quad (6)$$

4.2 Accordion Connection

Crash stone is carried to factories using durable, flexible and silk- reinforcement PE belt. Using bolts and initial displacement, the belt should be constrained around the joints area. It is notable that the belt would be made in two water proofing layers. Connection can be act as an accordion behavior where the deflection will apply on segmental parts.

5. Conclusion

Release processing will be provided by the accordion joint and knee steel balls. This new design will improve settlements problems in sea works, sewage pipeline, fresh water, river engineering, earthquake displacements, artificial intelligence behaviors and dam hydropower intakes.

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