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Numerical Investigation on Turbulent Flow in Blind Tees

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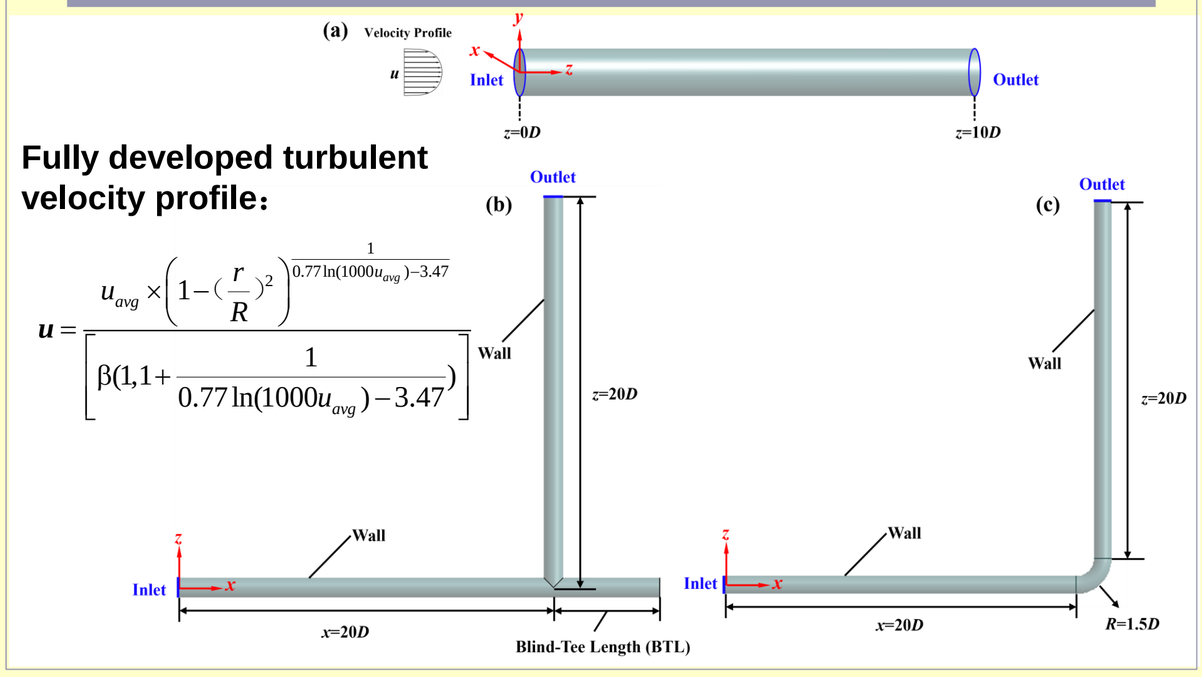
1. Abstract

Elbows and blind tees are two typical bending structures commonly used in offshore oil and gas pipeline systems. The primary purpose of this study is to explore the influences of different bending structures and Reynolds numbers on the fluid mixing conditions in turbulent flow regimes. To this end, three-dimensional numerical simulations have been carried out on a typical 90° elbow and blind-tee pipes with a fully developed turbulent inlet flow, and detailed flow characteristics inside blind tees are analyzed by changing the blind-tee length and Reynolds number to figure out their effects on the flow mixing conditions. This study can provide references for the design and improvement of offshore pipelines with bending structures.

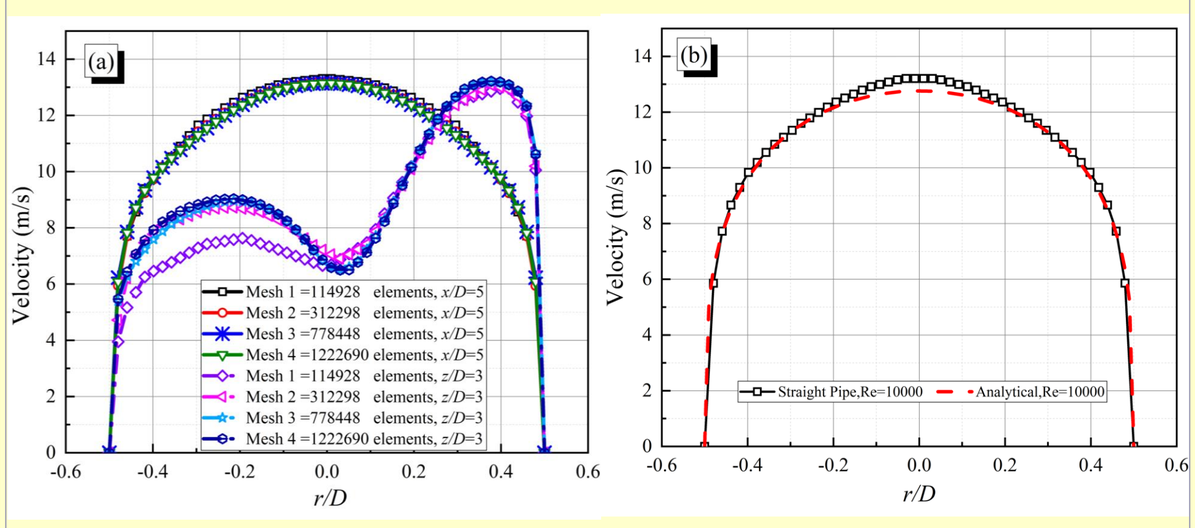
2. Numerical Model



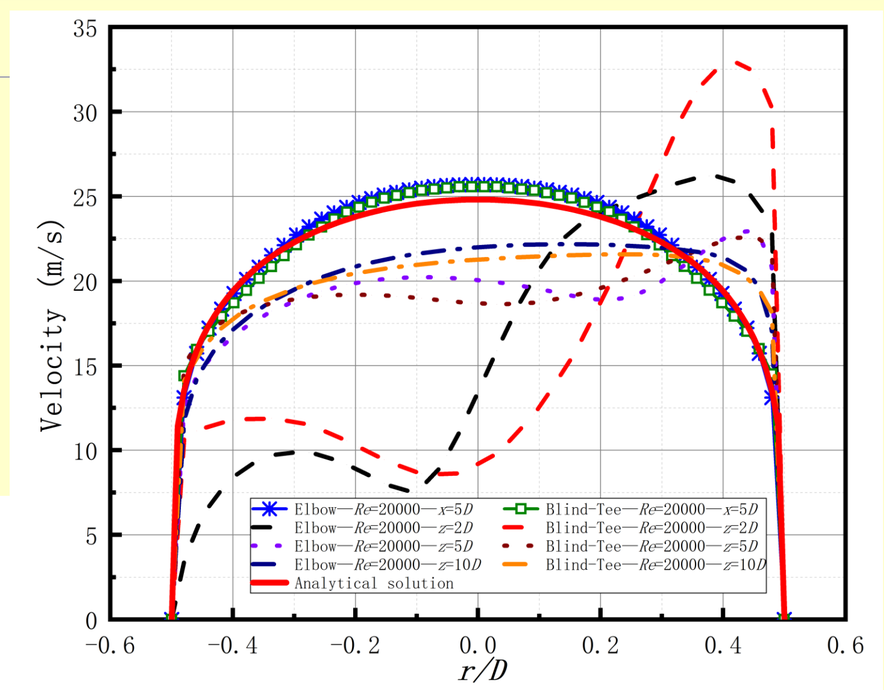
Fully developed turbulent velocity profile:

$$u = \frac{u_{avg} \times \left(1-(\frac{r}{R})^2\right)^{\frac{1}{0.77\ln(1000u_{avg})-3.47}}}{\left[\beta(1,1+\frac{1}{0.77\ln(1000u_{avg})-3.47})\right]}$$

3. Verification and Validation



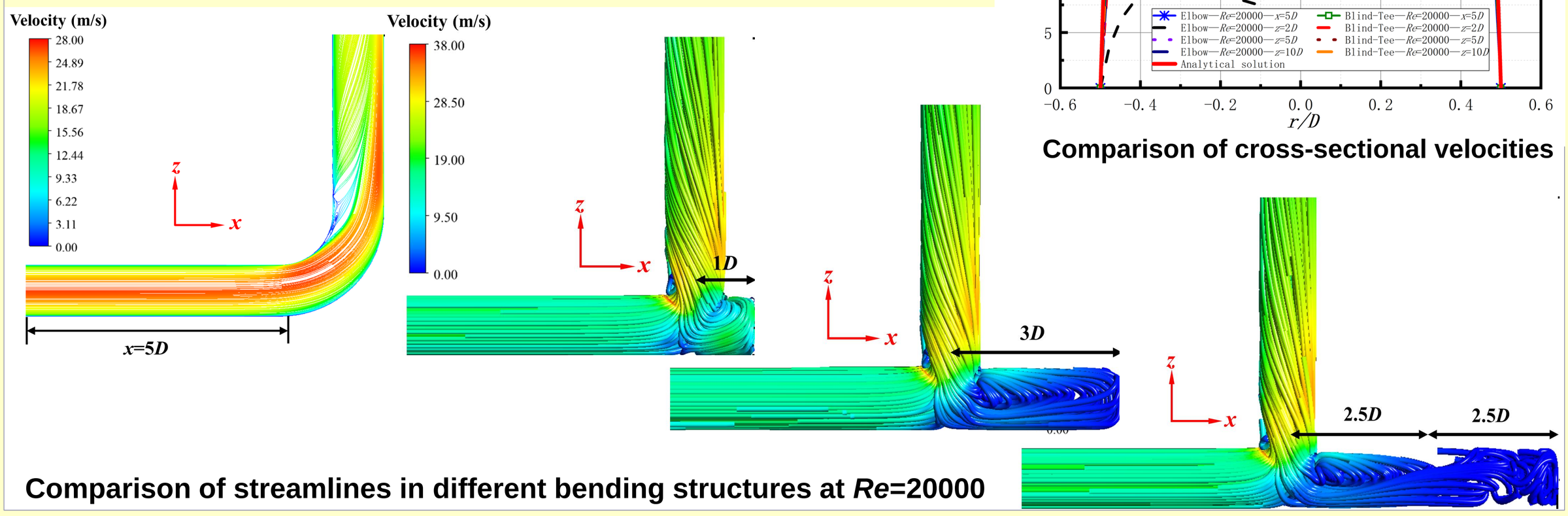
(a) Grid resolution test **(b) Validation study**



Comparison of cross-sectional velocities

4. Results and Discussions

The results indicate that the bending structure is a critical factor affecting the fluid flow, and blind tees have a better effect on the fluid mixing than the traditional elbow. With the increase of *Re* and BTL, the mixing effect of blind tee becomes weak, and the low-speed fluid is more likely to concentrate on the inner side of the downstream pipe.



Comparison of streamlines in different bending structures at *Re*=20000

5. Conclusions

By analyzing the flow characteristics in different bending structures under different Reynolds numbers, it is found that blind tees have a better effect on the fluid mixing than the traditional elbow. When BTL≤3*D* and *Re*≥20000, the pipeline transportation efficiency is the best, and there is no excessive liquid retention at the blind end.