

Relationship between Fabrication by Wire Arc Additive Manufacturing and Pump Performance in Low-Solidity Axial-Flow Impellers with Different Number of Blades

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INTRODUCTION & AIM

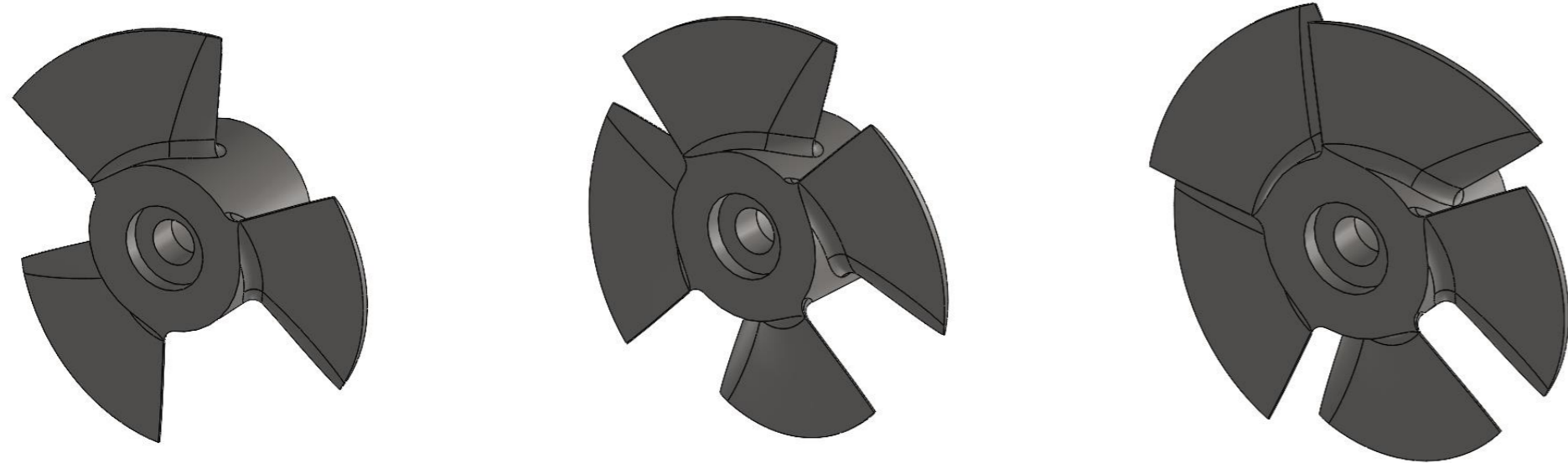
Several studies [1-2] have shown that the fabrication of impellers, one of the key elements of turbomachinery, by wire arc additive manufacturing (WAAM) can improve the fabrication process compared to traditional fabrication methods. However, there are problem that have not been discussed in the analyses conducted in these studies to the relationship with the hydraulic performance of the impeller. In this study, the analysis for two aspects of fabrication and pump performance was conducted for low-solidity axial-flow impellers with a focus on the number of blades.

TEST MODEL

The test model is a low-solidity axial-flow impeller. The 4-blade type is called a fan-type inducer and is attached to industrial centrifugal pumps.

Specifications

Number of blades	3, 4 & 5
Tip diameter	125.3 [mm]
Hub diameter	51 [mm]



METHOD

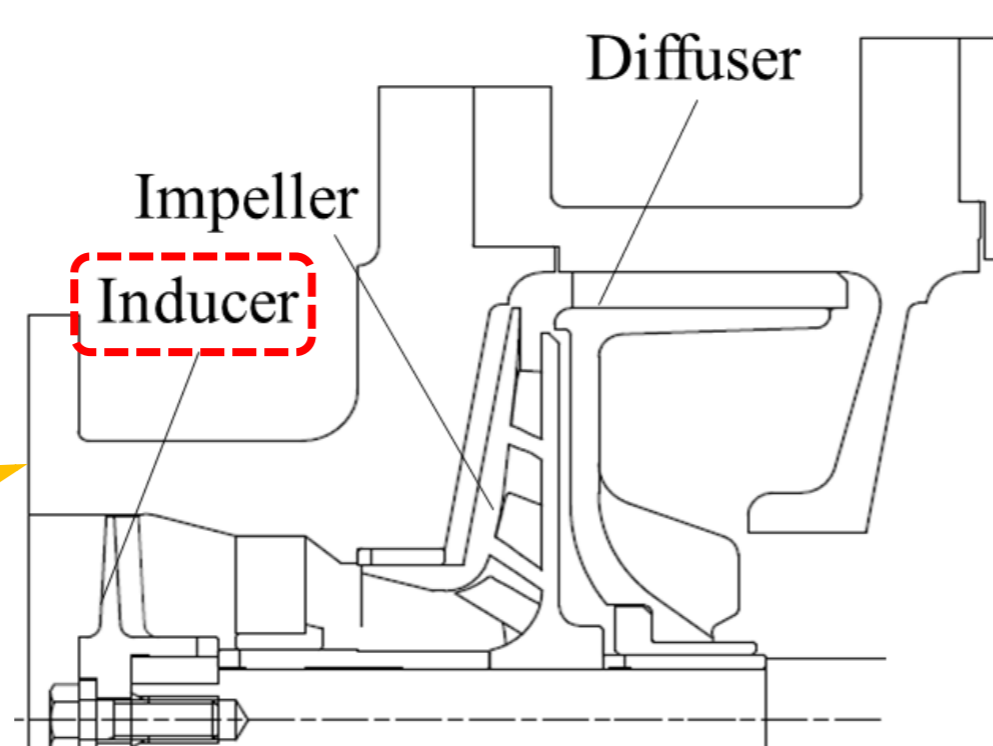
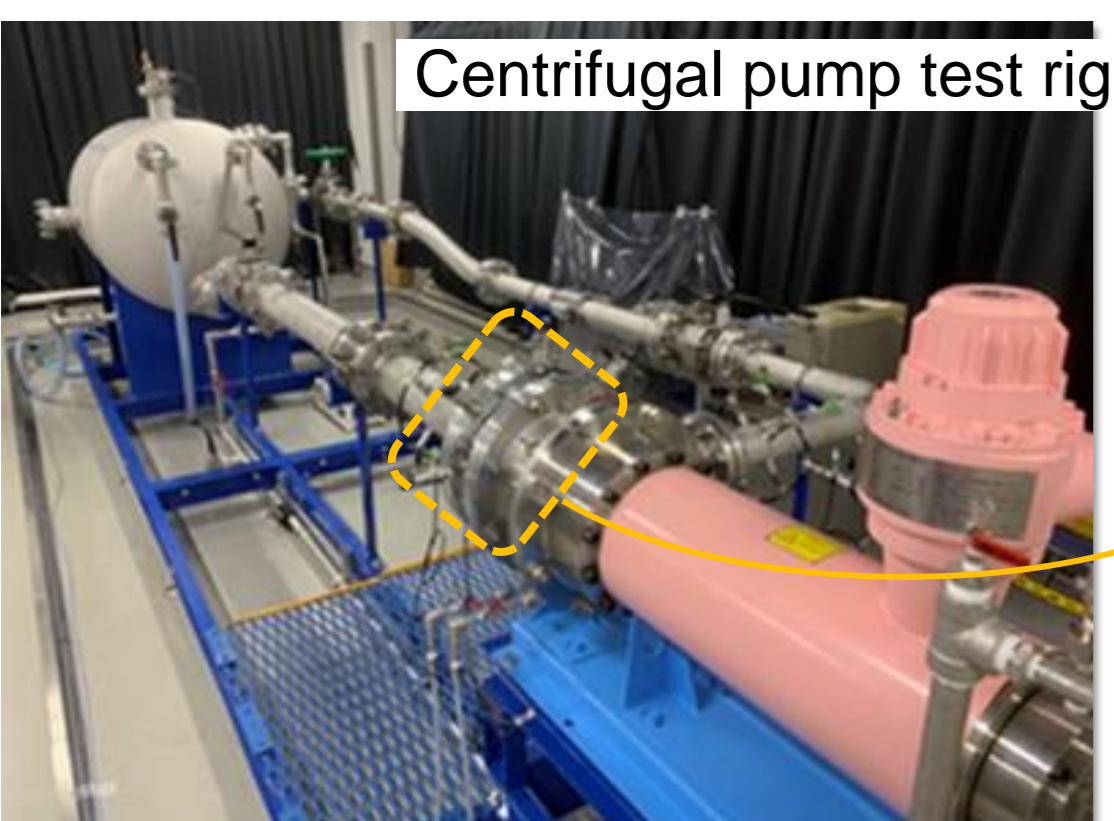
Fabrication using WAAM [1]

The near-net shape of a blade is additively manufactured by WAAM and finished by machining.



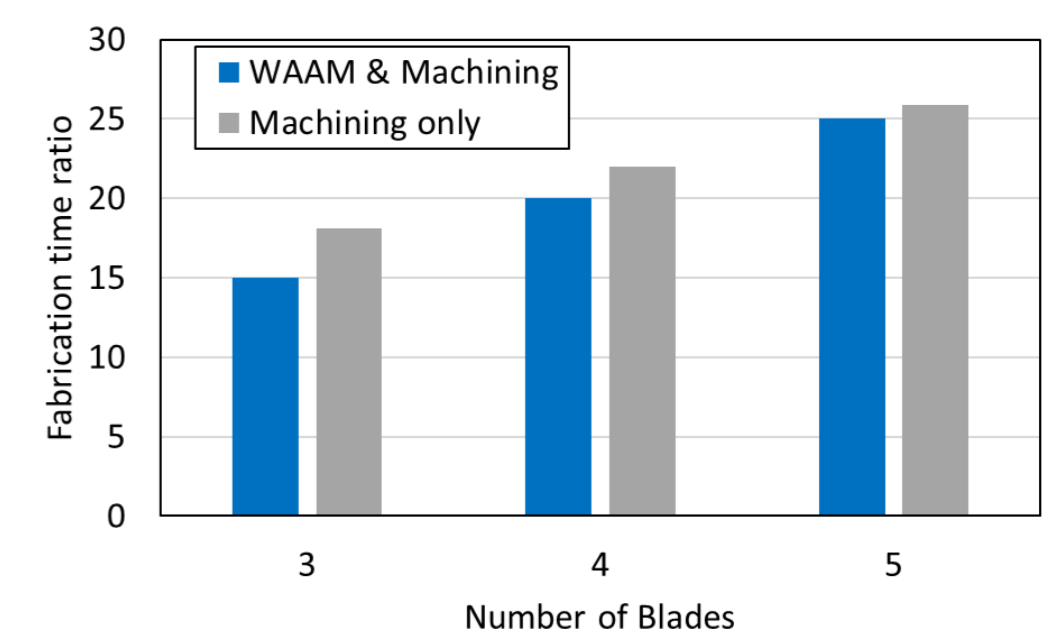
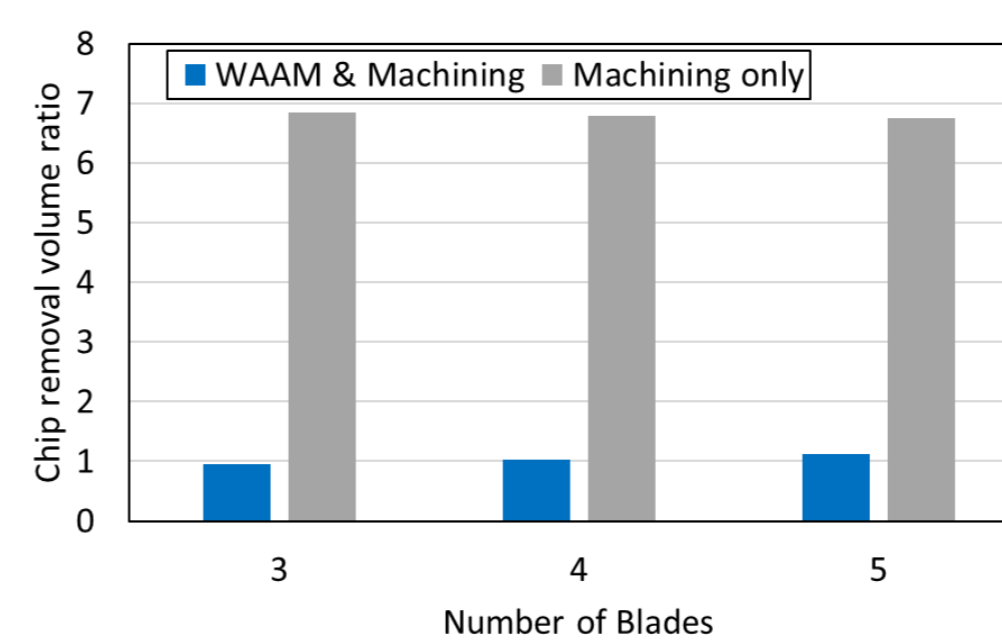
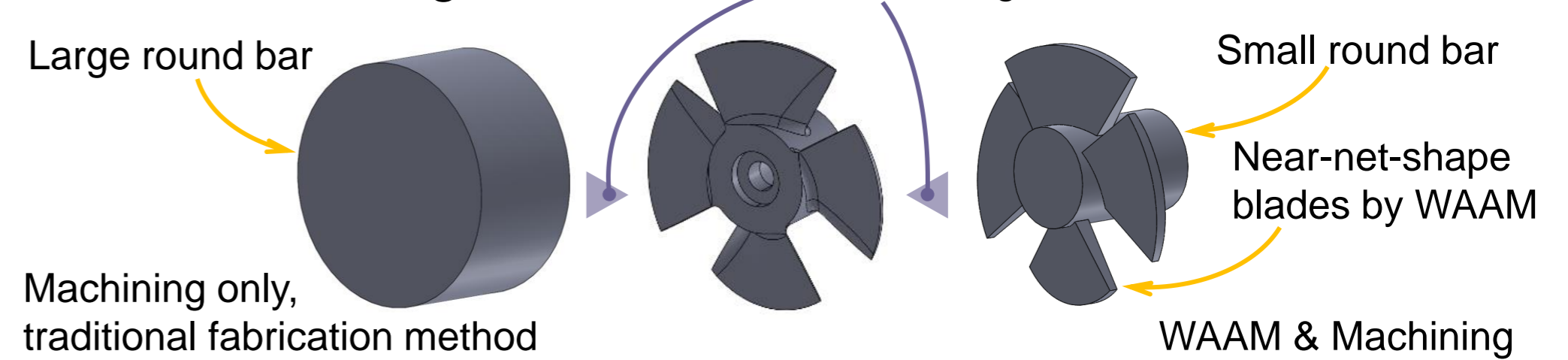
Pump performance test

The inducers attach a centrifugal pump. Q-H test for pump performance and NPSH test for pump suction performance are conducted based on JIS B 8301.



RESULTS & DISCUSSION

Fabrication using WAAM [3]

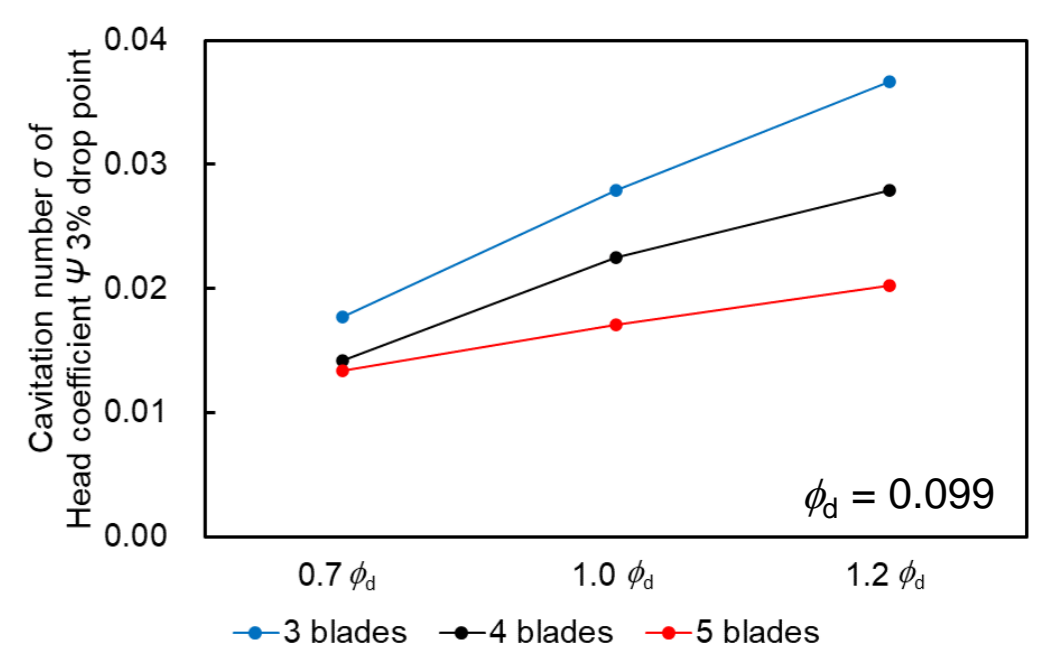
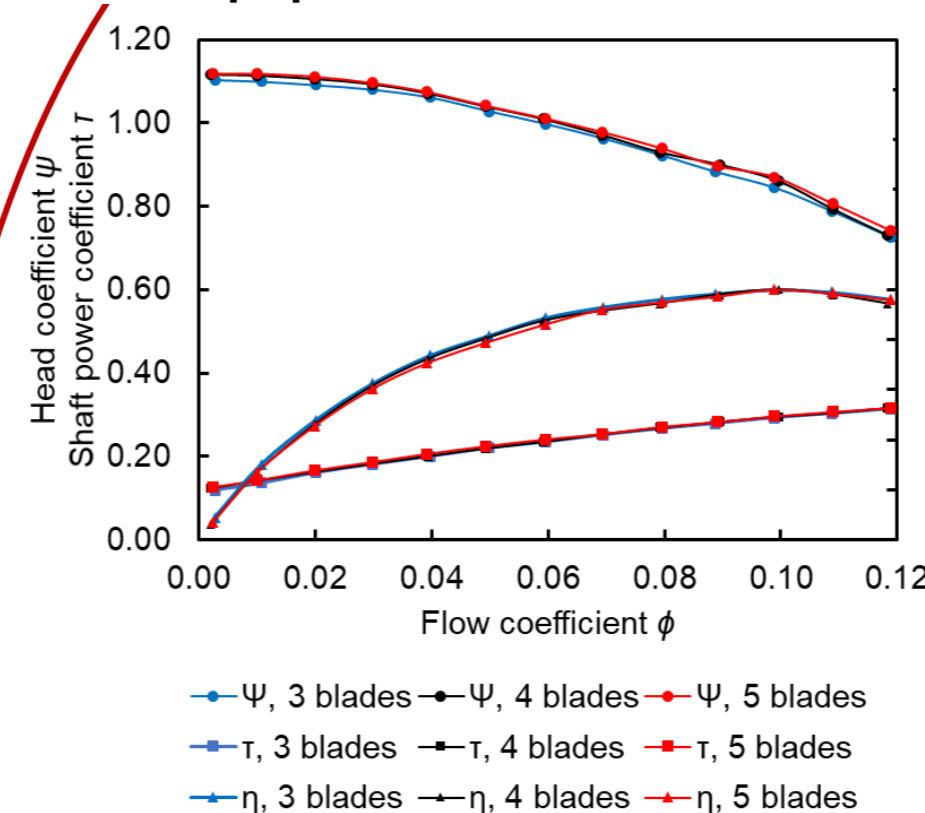


The amount of chips can be significantly reduced by application of WAAM, the effect is more advantageous the lower the number of blades.

The fabrication time can be reduced by application of WAAM, the effect is more advantageous the lower the number of blades.

In fabrication processes applying WAAM, a low number of blades is more advantageous.

Pump performance test



There is no clear difference in head coefficient ψ , efficiency η , and shaft power coefficient τ for all flow coefficients ϕ even when axial-flow impellers with different number of blades are attached as inducers.

Regarding the 3 percent drop point of the head coefficient ψ , which corresponds to the NPSHR, an evaluation index of pump suction performance, the higher the number of blades, the lower the cavitation number σ .

In improving pump suction performance, a high number of blades is advantageous.

Trade-off between fabrication using WAAM and pump suction performance.

CONCLUSION

In the case of low-solidity axial-flow impellers, there is a trade-off between the fabrication process advantage of WAAM and pump suction performance in use as an inducer.

FUTURE WORK / REFERENCES

The relationship between hydrodynamic performance and fabricability will be studied in detail by analyzing on axial-flow impellers with high solidity, open-type centrifugal impellers and others that can be fabricated using the WAAM.

- [1] S. Ejiri, *International Journal of Fluid Machinery and Systems*, **2023**, 16-2, pp.184-191.
- [2] S. Ejiri, *Engineering Proceedings*, **2024**, 76-1, 86.
- [3] S. Ejiri, *Engineering Proceedings*, **2024**, 67-1, 61.