IECMA 2026 Conference
The 3rd International Electronic Conference on Machines and Applications
12–14 May 2026 | Online
MDPI

Fan-Type Inducer for a Centrifugal Pump with Multi-Material Blades Made of Stellite 6 and SST 316L Additively Fabricated using Wire Arc Additive Manufacturing

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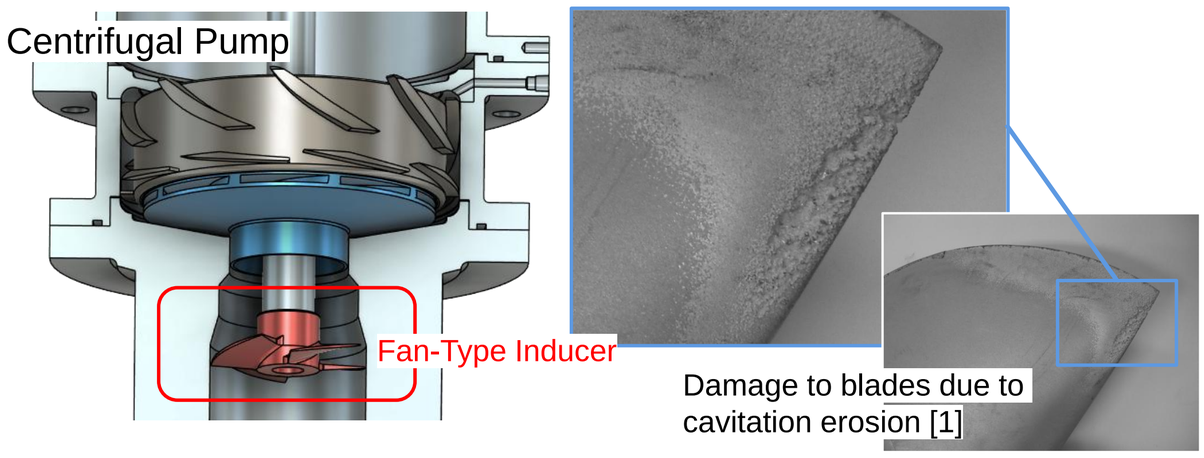
INTRODUCTION & AIM



A typical troubles in centrifugal pumps: cavitation erosion

This aims to develop a long-life fan-type inducer.

The multi-material structure by wire arc additive manufacturing (WAAM) was designed such that the region susceptible to damage from cavitation erosion uses a material with excellent cavitation erosion resistance, while the remaining regions use a conventional material. For clarifying its feasibility, tensile tests on the multi-material test piece are conducted, and a fan-type inducer with multi-material blades is fabricated.

METHOD

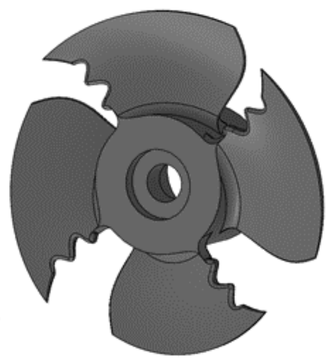
Tensile Test

- Multi-material specimen by WAAM & machining

- Tests in accordance with Japanese standards, JIS Z 2241

Fabrication of Inducer

- Design
  - Forward sweep and biomimetics of humpback whale flipper blades
  - Multi-material blades
    - Upper 1/3 of blade span: Stellite 6
    - Lower 2/3 of blade span: SST 316L
  - Tip diameter: 125 mm



- Fabrication method
  - Hub: Machining from round bar
  - Blades: Machining from WAAM
- WAAM conditions

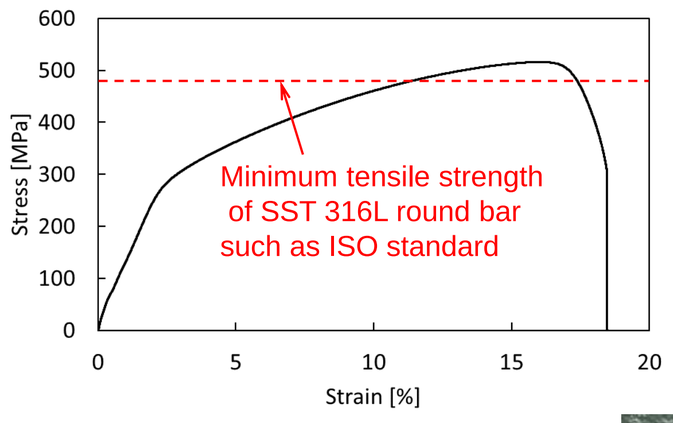
Material	Stelite 6	SST 316L
Current [A]	200	243
Voltage [V]	20.0	13.8
Wire feed [m/min]	6.8	9.0
Torch feed [mm/min]	600	600
Shield Gas	Ar	Ar

- Dimensional measurement via 3D scanning

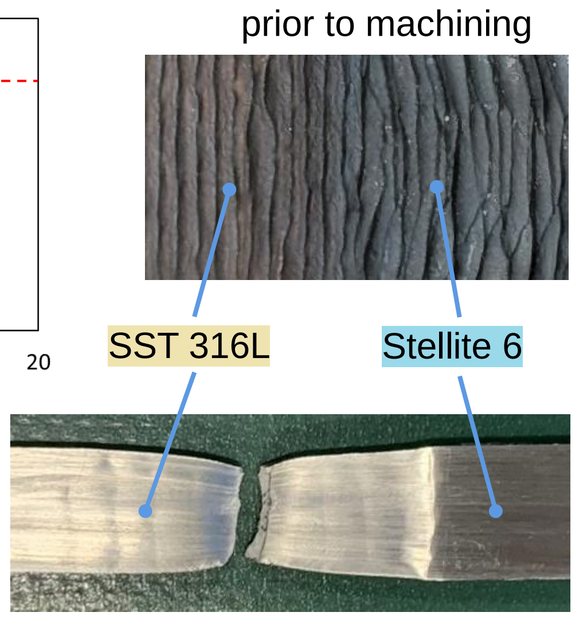
RESULTS & DISCUSSION

Tensile Test

Stress-strain diagram



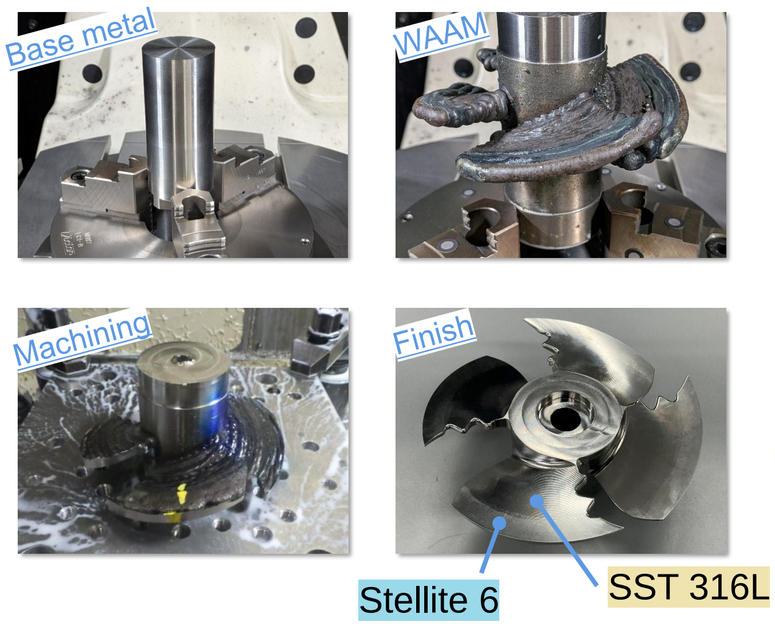
WAAM material prior to machining



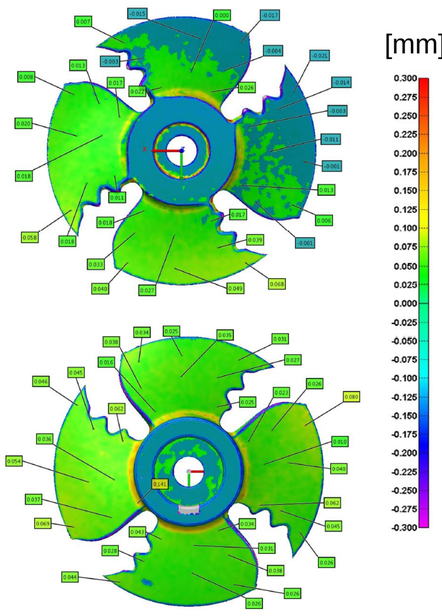
- Multi-material specimen broke at SST316 section.
- Tensile strength of multi-material specimen meet or exceeds required value for SST316L.

Fabrication of Inducer

Process



3D scan



- WAAM and machining processes enabled the fabrication of a fan-type inducer according to the design.

These results clarify that multi-material blades combining Stellite 6 and SST 316L are feasible using WAAM.

CONCLUSION

Blades with multi-material design using WAAM represent a technology that enables the development of long-life inducers with excellent resistance to cavitation erosion.

FUTURE WORK / REFERENCES

Evaluation of scaling up and other multi-material structures.

[1] Iga, Y., et al., Trouble Examples Due to Cavitation in Pumps 2, Turbomachinery, 52-5, (2024) pp. 258-266. (in Japanese)