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Technical Disclosure[1]

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Split Segment Molds for Overlapping Joints

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Technical Disclosure

5. Abstract

Disclosed is a modular molding system for manufacturing a blade, such as a wind turbine blade, from prefabricated blade parts or segments using multiple mold segments arranged for overlapping-joint formation. The system uses segmented molds provided with actuators, including 3D or 6-axis actuation capability, together with tracks that enable controlled alignment, movement, and positioning of the mold segments relative to one another. A prefabricated part can be supported in a first mold segment, moved to a subsequent mold segment, and joined through an overlapping region while additional layers are applied. Closed-loop feedback control may be used to maintain desired global blade geometry and alignment across the overlapping joints. The disclosed arrangement improves quality control and manufacturing process control for segmented blades and other segmented composite parts, particularly for longer blades.

6. Technical field

This disclosure relates to mold systems and manufacturing methods for segmented composite structures. More particularly, the disclosure relates to split or segmented molds configured for producing or integrating overlapping joints between prefabricated blade segments, including wind turbine blade segments, with accurate position control and geometry control.

7. Background

Manufacture of long composite blades and other elongated composite parts can present challenges in transportation, tooling, assembly, and dimensional control. Segmenting a blade or other large part into prefabricated sections can simplify logistics and fabrication, but introduces technical difficulty at the joint region, particularly where overlapping joints must be assembled with high dimensional precision.

Conventional approaches may not provide sufficient control over relative segment position, overlap alignment, or overall geometry during integration of one segmented part with another. These limitations can adversely affect assembly accuracy, joint quality, and final blade geometry. There is therefore a need for a mold system and associated process that supports precise assembly of

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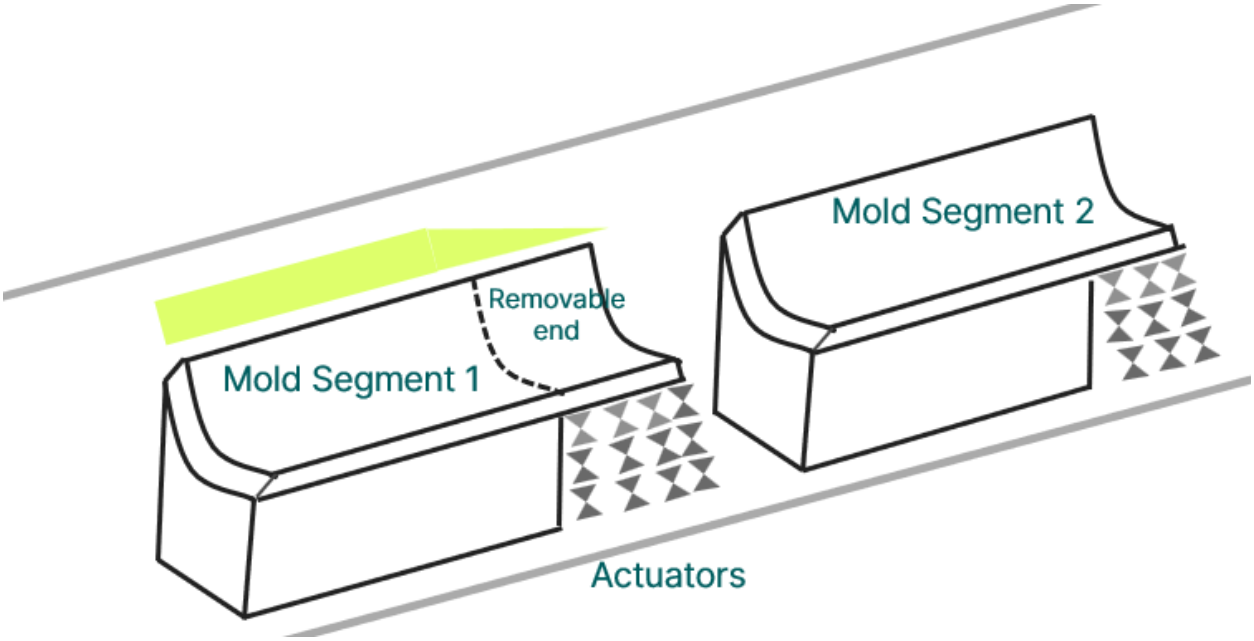
segmented blade parts while maintaining quality control and global geometric accuracy, especially for longer blades.

8. Summary of the disclosure

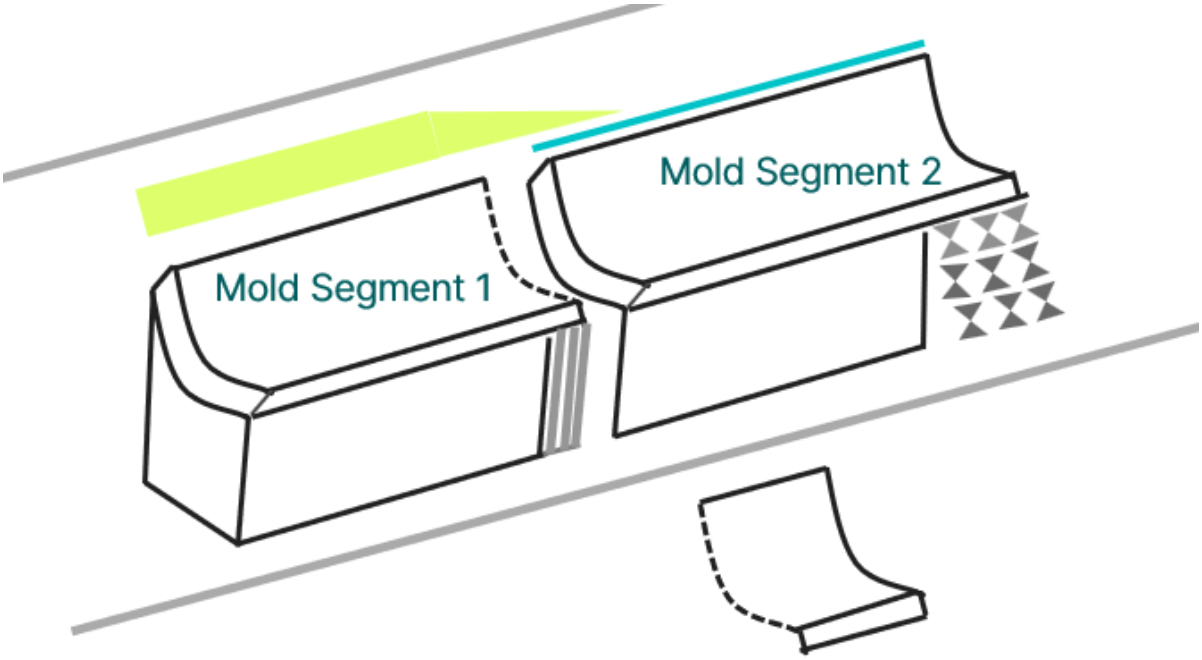
The present disclosure provides a split segment mold system for overlapping joints in segmented blade manufacture or segmented part integration. In one aspect, a first mold segment supports a completed or partially completed prefabricated blade part. The first mold segment may include actuators configured to control the position of the mold and supported part. The mold segments may be mounted on tracks to facilitate controlled movement and alignment.

In a representative process, the first mold segment carrying a prefabricated part is moved relative to a second mold segment so that an end region of the prefabricated part can be positioned onto the second mold segment. In some embodiments, an end portion of a mold segment is removable or adjustable to allow transfer and placement of the overlapping region. Additional layers may then be applied on the second mold segment to complete the next blade segment. Alignment between mold segments may be maintained by actuators, mold plugs, locking mechanisms, and/or closed-loop feedback control. The process may be repeated iteratively to manufacture a complete blade while maintaining overall geometry control.

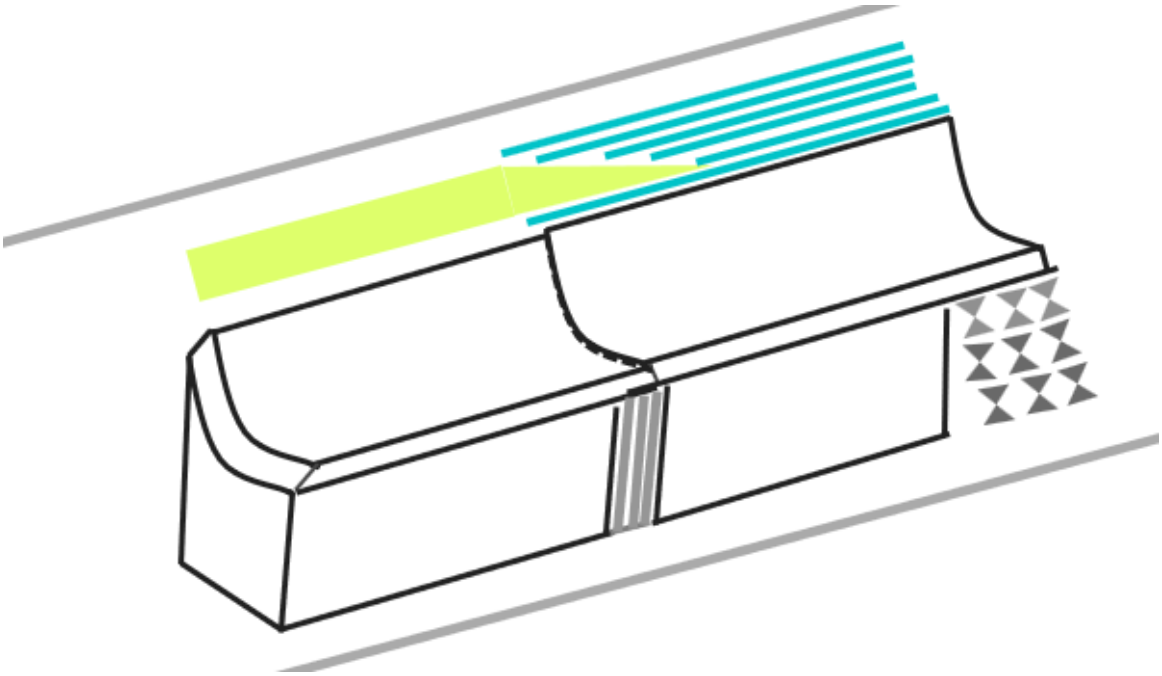
9. Brief description of drawings



[FIG. 1] illustrates transfer of the prefabricated part from a first mold segment toward a second mold segment, including a removable or adjustable end region of the mold.



[FIG. 2] illustrates positioning of the overlapping joint region on the second mold segment and alignment of adjacent mold segments.



[FIG. 3] illustrates build-up of additional layers over the overlapping joint region to complete a subsequent blade segment.

10. Detail description

A modular molding system is disclosed for creating a blade through a sequence of prefabricated parts and mold segments, or through integration of a single prefabricated part with one or more additional mold segments. The disclosed system is particularly suited for wind turbine blade manufacture, although it may also be applied to other segmented composite structures.

In one embodiment, a complete prefabricated part is arranged in a first mold segment. The first mold segment includes one or more actuators configured to control mold position, for example actuators providing 3D dimensional control and, in some instances, 6-axis actuation capability. Such actuation enables fine adjustment of mold segment position and orientation to achieve desired local and global geometry.

The mold segments may be set on tracks for alignment and movement. By using tracks, one mold segment carrying a prefabricated part can be moved toward another mold segment in a controlled manner. This facilitates repeatable positioning during the overlapping-joint manufacturing process. In some embodiments, the end part of a mold segment is removable, or an adjustable end of a mold segment is removed, so that the end region of the prefabricated part can be placed onto a subsequent mold segment.

After the prefabricated part is transferred or extended onto the second mold segment, a bottom layer may be placed on the second mold segment in preparation for forming the overlapping region. The position of mold segments 1 and 2 may then be adjusted by one or more actuators to ensure precise alignment. A mold plug or locking mechanism may be used to further ensure alignment between adjacent mold segments.

Once alignment is achieved, additional layers may be placed on top of the prefabricated part to complete the next blade segment. Closed-loop feedback control may be utilized throughout the process to control the global geometry of the blade. This feedback-based approach can be used to compensate for positioning deviations and to ensure that overlapping joints do not compromise overall blade shape.

The process may be repeated from one mold segment to the next until the final blade is completed. In this manner, the system enables a step-by-step manufacturing process for segmented blades or for integration of segmented parts using controlled overlapping joints.

11. Advantages

The disclosed system provides several technical and commercial advantages, including:

- improved quality control for overlapping joints in segmented blades or segmented parts;

- improved process control during assembly and manufacturing of long composite blades;

- accurate position control of segmented molds and corresponding overlapping parts;

- improved global geometry control across multiple blade segments;

- enhanced repeatability through the use of tracks, actuators, and feedback control; and

- practical support for manufacturing longer blades from prefabricated segments.

12. Example Embodiments

In one example embodiment, a first mold segment supports a completed prefabricated blade section. The first mold segment includes actuators for position adjustment, and the mold segment is mounted on tracks. The mold segment is moved toward a second mold segment so that an end region of the prefabricated section is positioned for overlap with the second segment.

In another example embodiment, an adjustable or removable end portion of the first mold segment is removed to permit the end of the prefabricated part to extend onto the second mold segment. A bottom layer is placed on the second mold segment, after which the relative position of the first and second mold segments is adjusted by actuators to obtain alignment.

In a further example embodiment, a mold plug or locking mechanism is used between adjacent mold segments to preserve alignment while additional composite layers are added over the overlapping region. Closed-loop feedback control is used to monitor and control blade geometry during the integration step.

In another embodiment, the foregoing sequence is repeated over multiple mold segments to create a complete segmented blade in a progressive manufacturing process.

13. Industrial Applicability

The disclosed split segment mold system is applicable to industrial manufacture of wind turbine blades, particularly large or long blades that benefit from segmented fabrication and assembly. The disclosure is also applicable to manufacture of other large composite parts in which overlapping joints between prefabricated segments require accurate alignment and geometry control. The system can be used in production environments seeking improved consistency, dimensional control, and process efficiency.

14. Variations and Alternatives

Various modifications may be made without departing from the scope of the disclosure. For example, the number of mold segments may vary depending on blade length, part geometry, or production strategy. Different actuator arrangements may be used, including alternative multi-axis positioning systems. Tracks may be replaced or supplemented by other guided movement systems. Alignment may be achieved by any suitable combination of actuators, plugs, pins, locks, clamps, fixtures, or feedback-based control elements.

The disclosed process may be used with a series of prefabricated blade parts, or with a single prefabricated part that is progressively extended across multiple mold segments. The overlapping-joint configuration, composite layup sequence, and layer build-up approach may also be adapted to suit different blade architectures or segmented composite parts.

15. Conclusion

This disclosure describes a split segment mold system and associated manufacturing process for forming overlapping joints between prefabricated blade segments or other segmented composite parts. By combining segmented molds, actuator-based position control, guided movement on tracks, removable or adjustable mold end regions, alignment mechanisms, and closed-loop feedback control, the disclosed system enables accurate assembly and improved geometry control

across joint regions. The approach is particularly useful for segmented manufacture of longer blades and provides meaningful quality and process improvements over less controlled assembly methods.

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