Innovative Shuttle Weaving Machines for Composites and Special Applications

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1 Introduction

Research Association with MAGEBA Textilmaschinen GmbH & Co. KG

- Development and modification of new weaving machines and auxiliary equipment for productive processing of high-performance yarns on shuttle looms

- Processing of high-performance yarns in warp and weft direction of shuttle looms with higher productivity and lower damage aspired

- Leads to structures with performance according to the requirements

- New highly complex and productive woven 3D structures are possible due to this cooperation
2 Motivation

1. Rising demand for complex structures
2. High amount and costs of preforming
3. Searching for possibilities to reduce preforming effort
   → Shuttle looms got high potential for production of near netshape woven structures
   → Due to the “endless” weft yarn insertion complex woven tube structures are possible

But: Productive and damageless processing of high performance yarns causes new developments on the shuttle looms.

Source: AIRBUS S.A.S.
Source: BMW AG
Source: Institut für Verbundwerkstoffe GmbH
3 Developments on weaving machines

- Servo-controlled warp tension system developed for compensation of free warp length during weaving process.
- Warp tension very important for load adapted composite structures as well as for medical textiles.
- System allows low yarn tension amplitude together with significant lower yarn tensions.
- System works by operating forwards and backwards to compensate shed openings and reed compression.
3 Developments on weaving machines

- Development of weave patterns for medical textiles
- Visualisation of highly complex woven structures
- Possibilities to test machines on different structures for customers
- Possibility to create new structures for medical and composite applications
- Possibility to create weave patterns for load adapted high performance structures
3 Developments on weaving machines

- Newly developed dobby construction with servo-controlled single shaft engine
- Due to the dobby construction different shed opening heights for weft insertion possible
- Processing of different shuttles with different size and weft material
- Opening of multiple sheds at one weft insertion for production of spacer fabrics or higher productivity
- Higher flexibility and productivity of the shuttle looms
3 Developments on weaving machines

- V-Reed construction with tensionable reed sheets
- Servo-controlled vertical movement of the V-reed for precise width of the woven fabric
- Used for medical textile production
- Different cross-section diameters in one structure
- Working of different yarn materials due to adjustable sheet tension at the V-reed

V-reed construction for highly accurate textiles

Structure produced with a V-reed
3 Developments on weaving machines

- New shuttle rapier loom with shuttle handover from one rapier to another
- Higher width of the woven fabric possible
- Higher machine productivity due to multiple shuttle insertion
- Processing of different yarn types at the same time possible
- Production of spacer fabrics and other 3D-woven structures with higher productivity and bigger dimensions possible
3 Developments on weaving machines

- Processing of high performance yarn with special heddles
- Significant reduction of yarn damage
- Adaption of special heddles to a jacquard machine for multi layered woven structures
- Due to this reduced damage of the warp yarn load-adapted composite structures are possible
- New possibilities for woven structures for composites
3 Developments on weaving machines

- Developed a complete new pattern system for 3D-woven structures
- Patterns for tubular structures for structures with different cross sections in length direction
- Weaving of nearnet shape structures for medical and composite applications
- Development of complete new structures only producible on shuttle looms
- Structures desired by the automotive and aeronautics engineering as well as by medical engineering and technology
3 Developments on weaving machines

- Development of a complete new shuttle system for woven structures made of high performance fibres
- Includes a new adjustable braking and compensation system for the weft yarn
- All contact points for the weft yarn with radii > 8 mm

**Tensile strength of carbon fibres processed with the new shuttle**

- Original C-Roving
- Hauled off of new bobbin
- Hauled off of new shuttle with low yarn tension
- Hauled off of new shuttle with maximum yarn tension
- Released from 4 layer atlas fabric
- Released from 4 layer twill fabric
- Released from 4 layer canvas fabric

**Tensile force on the weft yarn during weaving process**
3 Developments on weaving machines

- Shuttle loom needed to process high performance yarns with higher productivity and same properties of the older shuttle
- New shuttle developed with the possibility to wind the bobbin directly on the machine
- All innovations of the shuttle shown before are integrated
- New shuttle has an spread clutch, two bearing sleeves and drill holes
- With these parts the winding of the bobbin is possible
3 Developments on weaving auxiliary equipment

- Shuttle bobbin capacity too low to process high performance yarns with high productivity
- Therefore an automatic working shuttle changer is developed
- It leads empty shuttles out of the machine into a storage and replaces them automatically with a full shuttle
- With a storeroom for three shuttles and a place for an automatic winding unit
- Also highly recommended in cases of complex structures with weft yarn changes
3 Developments on weaving auxiliary equipment

• For complex structures with predetermined weft insertion order another shuttle changing concept is needed

• Newly developed rotating shuttle changer allows interchanging of different shuttles without cutting weft yarns

• Up to 16 shuttles in a storeroom and a place for a automatical winding unit

• A complex yarn guiding system developed

Designed for all MAGEBA shuttle looms
3 Developments on weaving auxiliary equipment

- On basis of the new developed shuttle a automatical winding unit is created
- Allows the online winding of empty shuttle bobbins on the automatical winding unit
- Solution found to keep the compensation force upright
- One engine needed to spin the shuttle
- Adapter on the engine fits in the axle with the spread clutch the drill holes
- Bobbin winding unit for automatical yarn winding on the shuttle loom
3 Developments on woven textiles

- Woven structures of the ITM woven on a MAGEBA shuttle loom show the potential of a modified shuttle loom.
4 Outlook and conclusion

• All shown developments lead to an more productive weaving machine to produce medical or composite structures

• The automatical shuttle changer makes it possible either to increase the production process for complex woven 3D-composites preforms and reduces costs

• With these developments it is possible to increase the mechanical properties of woven preforms in warp and weft direction by using the servo-controlled warp tension system, the special heddles and the new shuttle

• In addition the weaving machines make it now possible to create highly complex structures due to the multi weft insertion and multi shed opening

• The base for these highly demanded structures for medical, aeronautics and automotive engineering is set on sides of the machine and on the side of the weave pattern
Thank you for your kind attention!

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