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DESIGN, MANUFACTURE, TESTING AND EXPLIATATION OF THE POWER STATION'S COOLING TOWER COMPOSITE FAN BLADE

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ABSTRACT
This paper presents the way from design, manufacture and testing to exploitation of the power station's cooling tower composite fan blade. Design and modeling are carried out by the use of program moduli connected with the airfoil data base. Among them, there are: aerodynamic analysis, determination of centrifugal forces, torque, shear and normal stresses. In the final stage of the design it has been applied a system for automatic delivery of of technical documentation of composite fan blade. Geometric description is supported by program packages AutoCAD. This part is realised by program language AutoLISP. Before actual production of blades, it has been necessary to design and manufacture a proper mould, according to the blade geometry data. Mould is made of composite material, by "dry" procedure. In addition to the mould, it was also necessary to design and manufacture the polimerisation furnace. Fan blades are made of composite material, by "wet" procedure. Before the final mounting there is a visual inspection of the blades and corresponding joints. After the inspection, the blades are mounted with certain angle of attack, and are being dynamicaly balanced. After the balancing, the tower is ready for service. During their service, there are periodical inspections of blades.
Keywords: Redesigning, manufacture, testing, AutoCAD, AutoLISP, composite materials

1. INTRODUCTION

During past several years there existed constant need for spare blades in cooling towers of power station "Kolubara", which couldn't be obtained normally (original blades were imported from foreign manufacturer). That was the main reason for entering the process of their development, design and production. Since the user did not posses detailed technical documentation which contains data for reconstruction of original shape, there came up a problem of redesign, rather than simple coping on the basis of existing blades. This procedure had to be carried out in accordance with world wide accepted standards. In this program, material is the only one imported component, while the cost of blade is concurrent to the cost of foreign manufacturer blade.

2. REDESIGN

Redesign often includes several global aspects, mostly opposite, that should be in accordance, in order to find optimal solution for effective performance of a blade during its excessively long service life. Members of the Aerospace Institute at the Faculty of Mechanical Engineering in Belgrade, placed as a goal reproduction of original blade shape, as much accurate as possible. Therefore it was adopted a concept of redesign of a blade aiming to accomplish its virgin characteristics like: effectiveness, working stability, reliability and service life. Blade model which served as a reprint for production of

composite mold, were shaped on the basis of computer data. Metal frame which represented mold reinforcement, was designed in ALGOR, program package for structural analysis.

3. TECHNICAL DOCUMENTATION

Technical documentation was worked out in a program package AutoCAD, which was upgraded with several moduli, developed in the Aerospace Institute at the Faculty of Mechanical Engineering in Belgrade. With our system for automatic delivery of technical documentation of cooling tower fan blade, we accomplished following advantages: shorter design stage, smaller engagement of designer, higher level of working conditions, higher quality of documentation, smaller cost of segment design, smaller cost of whole system design, and smaller cost of assembly of the whole work in unique project.

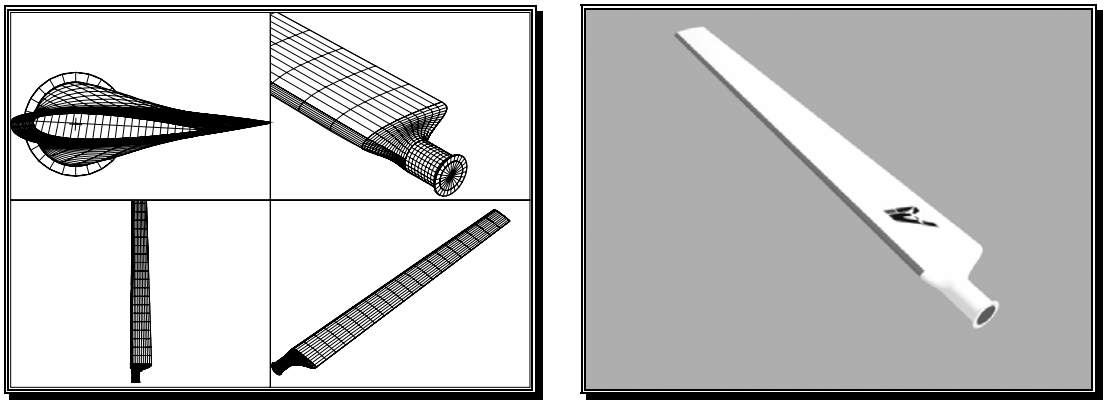

Figure 1. a) 3D model, b) rendered 3D model of blade, in 3D Studio

The system for automatic delivery of technical documentation, of cooling tower composite fan blade had as a tusk to provide for automatic or automated constructive and/or part drawings in standardized formats and in standardized scale. It should be mentioned that this system is in accordance with ISO9000 standard.

4. MANUFACTURING OF A MOLD

Before production stage of fan blade, it was necessary to manufacture an appropriate mold on the basis of defined geometry of blade. Molds were made of composite material, by "wet" procedure. The process is shown in the Figure 2.

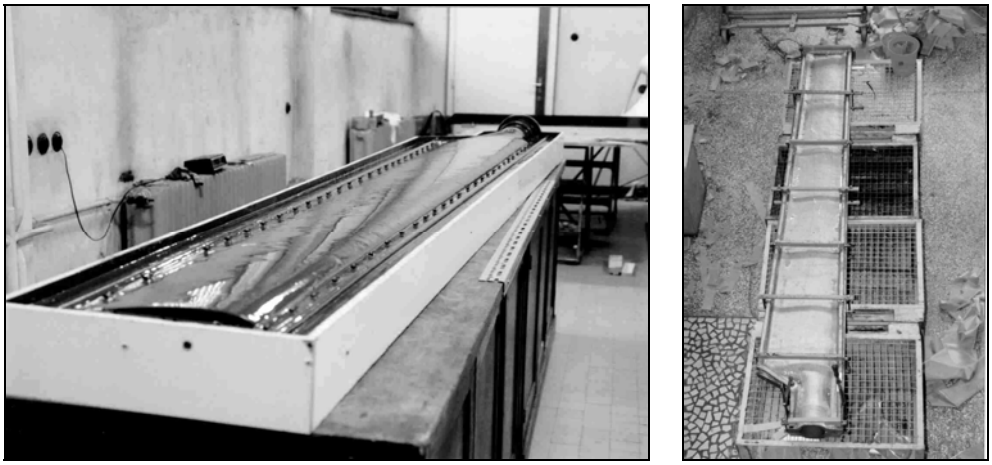

Figure 2. Mold in the production stage and mold with the metal frame

5. PRODUCTION OF BLADES

Fan blades were made of advanced composite materials (impregnated with Epoxy resin), by "dry" procedure, Figure 3.

Figure 3. Assembly of the mold and work on blade halves

Final stage of composite blade production is polymerization in the furnace. Due to specific requirements associated with composite materials, it was necessary to make a computer controlled polymerization. It means that computer, with additional moduli controls temperature in the furnace, thus satisfying required conditions of polymerization. Figure 4 represents a scheme of links between polymerization furnace and computer.

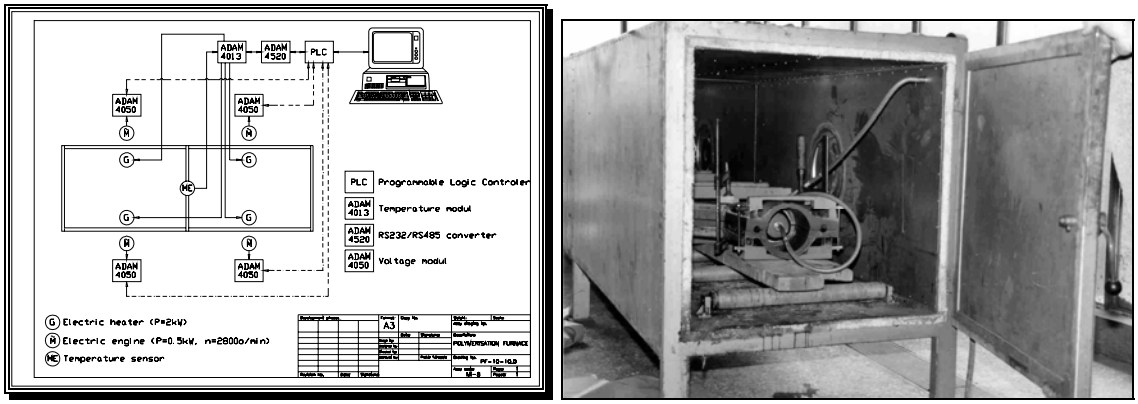

Figure 4. Computer and furnace linkage and blade prepared for the polymerization

6. TESTING OF BLADES

There has been carried out several static (determination of neutral axis, torsional and flexural stiffnesses), dynamic (tension and cyclic loading at one million cycles, determination of natural frequencies, etc.)and other tests that are required by the standard, Figure 5.

Figure 5. Testing of first and second kind of blade

7. TUNING AND CONTROL OF BLADES

After being mounted on the cooling tower, blades and joints are visually inspected. After that, the blades are positioned at the desired angle of attack and dynamically tuned. The cooling tower now could be set in service. Finally, there ought to be a periodic inspections of blades that are operational, Figure 6.

Figure 6. Mounted blades

8. CONCLUSION

Program of development, design, manufacture and control of cooling tower composite fan blade of power station "Kolubara", consists of fundamentals in redesign, through investigation of aerodynamic, strength and technological aspects. For these purposes, there has been made several programs for geometrically defining of blades and computing aerodynamic and inertial loads and resistance.

Technical - technological documentation was worked out using program package AutoCAD. With all possibilities of program package AutoCAD and some additional moduli, following could be accomplished: quick and easy training of working team, unifying of technical documentation, completion of the documentation with no regards to who and where he has done his design part. Thus it was possible to make an effective team work of associates within one and more working units. Application of these moduli and AutoCAD program has already shown its advantages in the Aerospace Institute at the Faculty of Mechanical Engineering, Belgrade.

Eventual occurrence of errors in technical documentation is minimized, and with automatic generating of technological documentation, it was achieved high order in formulating project as a whole. All parameters used in the moduli are in agreement with JUS and ISO9000 standards.

9. REFERENCES

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