FINITE ELEMENT METHOD IN SHIP'S INDUSTRY

METÓDA KONEČNÝCH PRVKOV V LODNOM PRIEMYSLE

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Summary: FEM means finite element method that is used in all fields of engineering for analysis of structural behavior in real conditions and also behavior of conditions themselves, which is used for example in CFD (Computer Fluid Dynamics). Nowadays these kinds of analysis have irreplaceable position in all kinds of industry.

Key words: ship industry, river, engineering, finite element method

Anotace: Metóda konečných prvkov je výpočtovou metódou používanou snáď vo všetkých odvetviach strojárskej výroby za účelom analýzy konštrukcie, jej prvkov vystavených reálnym okolitým podmienkam, ale taktiež správaniu sa samotných okolitých podmienok. Táto metóda sa taktiež používa i v CFD (Computional Fluid Dynamics). V súčasnej dobe tieto druhy analýz majú nezastupiteľné miesto vo všetkých druhoch priemyslu.

Klíčová slova: loďní průmysl, řeka, strojírenství, metoda konečných prvků

INTRODUCTION

To develop good products, design engineers need to study how their designs will behave in real-world conditions. Physical prototyping is an expensive, time-consuming way to do this, and the usual alternative - traditional numerical analysis - depends on highly trained specialists to get accurate results. Fortunately, there's a way to simulate the performance of your designs that doesn't have these drawbacks.

1. APPLICATION OF FINITE ELEMENT METHOD

FEA is an analytical method used by engineers to help determine how well structural designs survive in actual conditions such as stress, vibration, heat, and other forces. FEA operates on the premise that a complex structure can be divided into smaller elements to form a finite element model simulating the structure's physical properties. The model is subjected to rigorous mathematical analysis. The results of the analysis, can then be reviewed by the user in a variety of, formats. FEA significantly reduces the time and costs associated with prototyping and physical testing.

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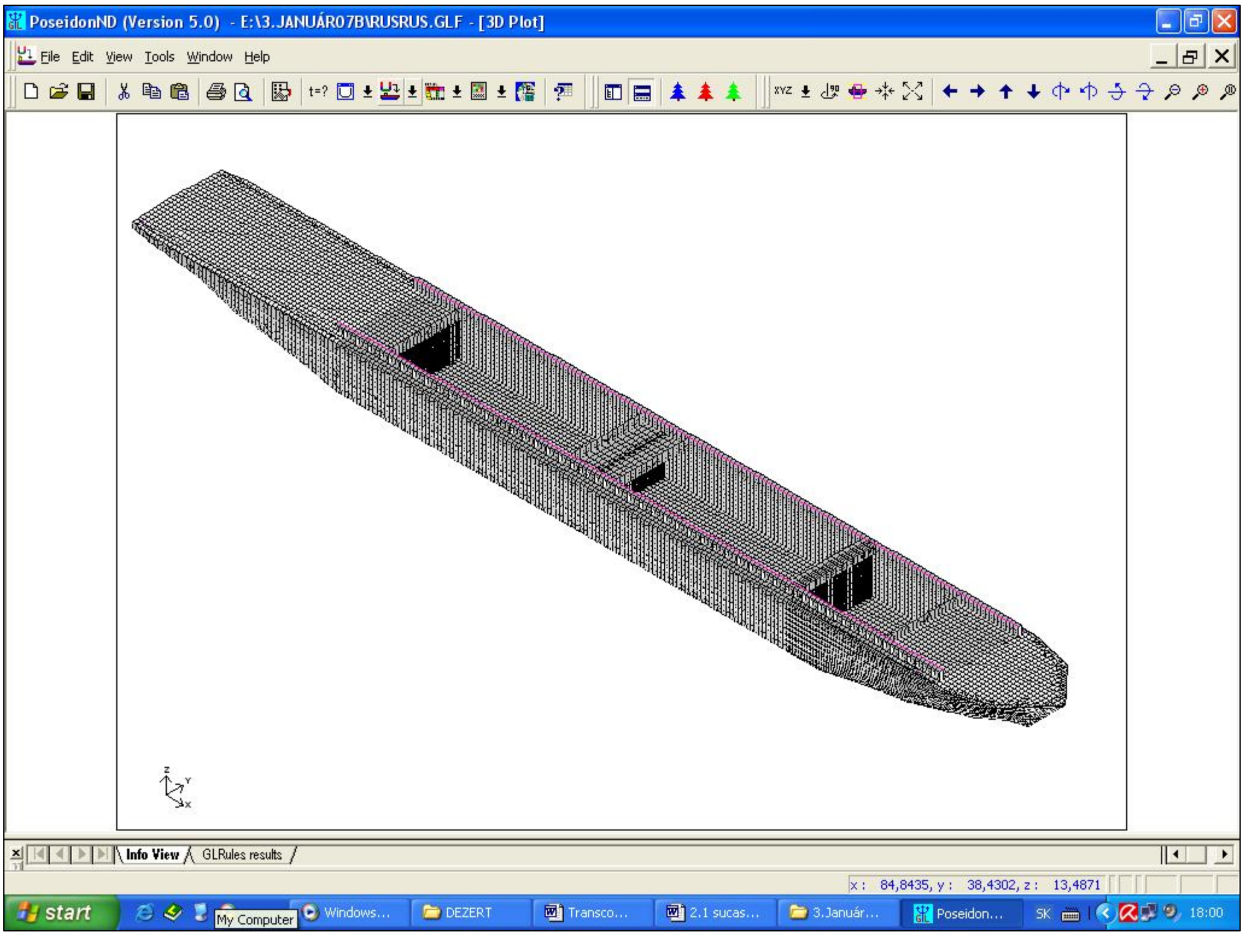
They are effective tools for design engineers to solve any kind of structural problems for every purpose such as statics, dynamics, buckling, electromagnetics, fluid dynamics etc. Good engineering background is required to use them effectively. FEA is valuable tool for any area of a marine vehicle design specially for analyzing of composites and/or unusual hull forms, engine room ventilation optimizations, silent propeller designs, electromagnetic performance analysis of mine warfare vessels and submarines, collision simulations, fatigue simulations of hull structures and much more...

Structural analyzing of ships need special algorithms to work faster and more effective. For example modeling of the boundary conditions are very different of a ship than a steel building. The objective of the procedure is to determine the response of the ship's structure to applied static and dynamic loads and to verify the structural response against acceptance criteria for stress, deflection and buckling. Structural integrity is of paramount importance during the service life of a ship.

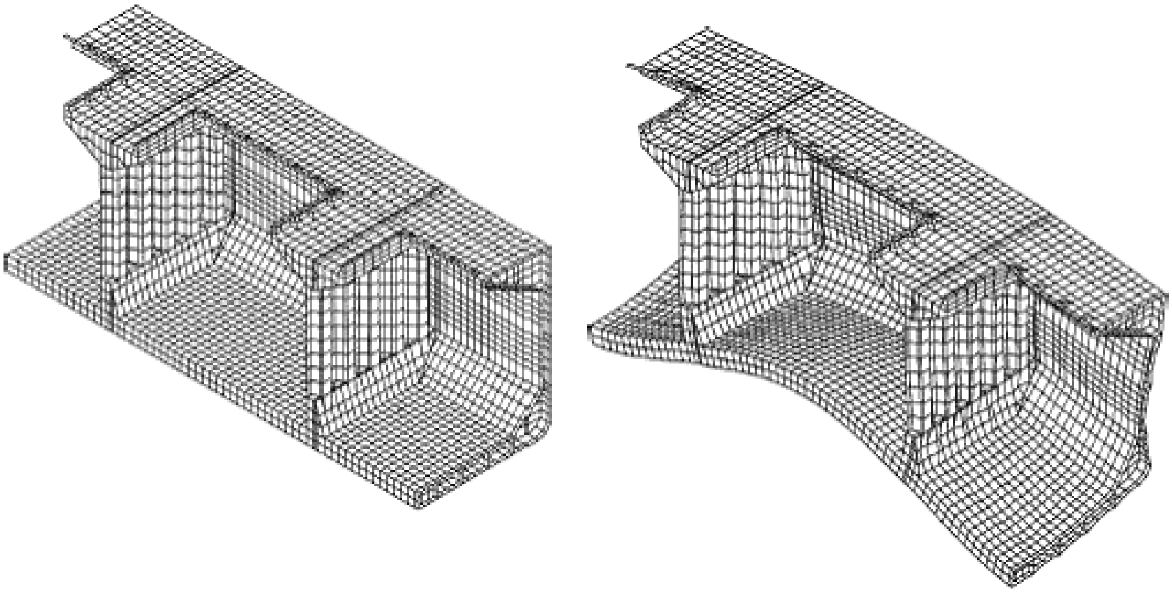


Source: [3]

Fig. 1 - Model of a Sea-River going ship

Therefore several structural analysis software are developed by the leading ship classification societies. For example Germanisher Lloyd - Poseidon ND, American Bureau of Shipping – SafeHull, Norske Veritas - Nauticus Hull etc. This software uses finite element analysis technology and generally targets to design large steel vessels.

General purpose finite element codes can deal with static and dynamic beam analyses for linear and non-linear conditions very well. But if you work only for beam structures these types of software (For example Visual Analysis, Multiframe, Cadre etc.) can do nearly the same job with lower cost and shorter learning time. An engineer with this kind of tool should be able to model and solve essentially any structure that can be idealized with slender beams and/or thin plates. The construction elements include 2 types of triangular plates, springs, wires, and beams of several configurations.

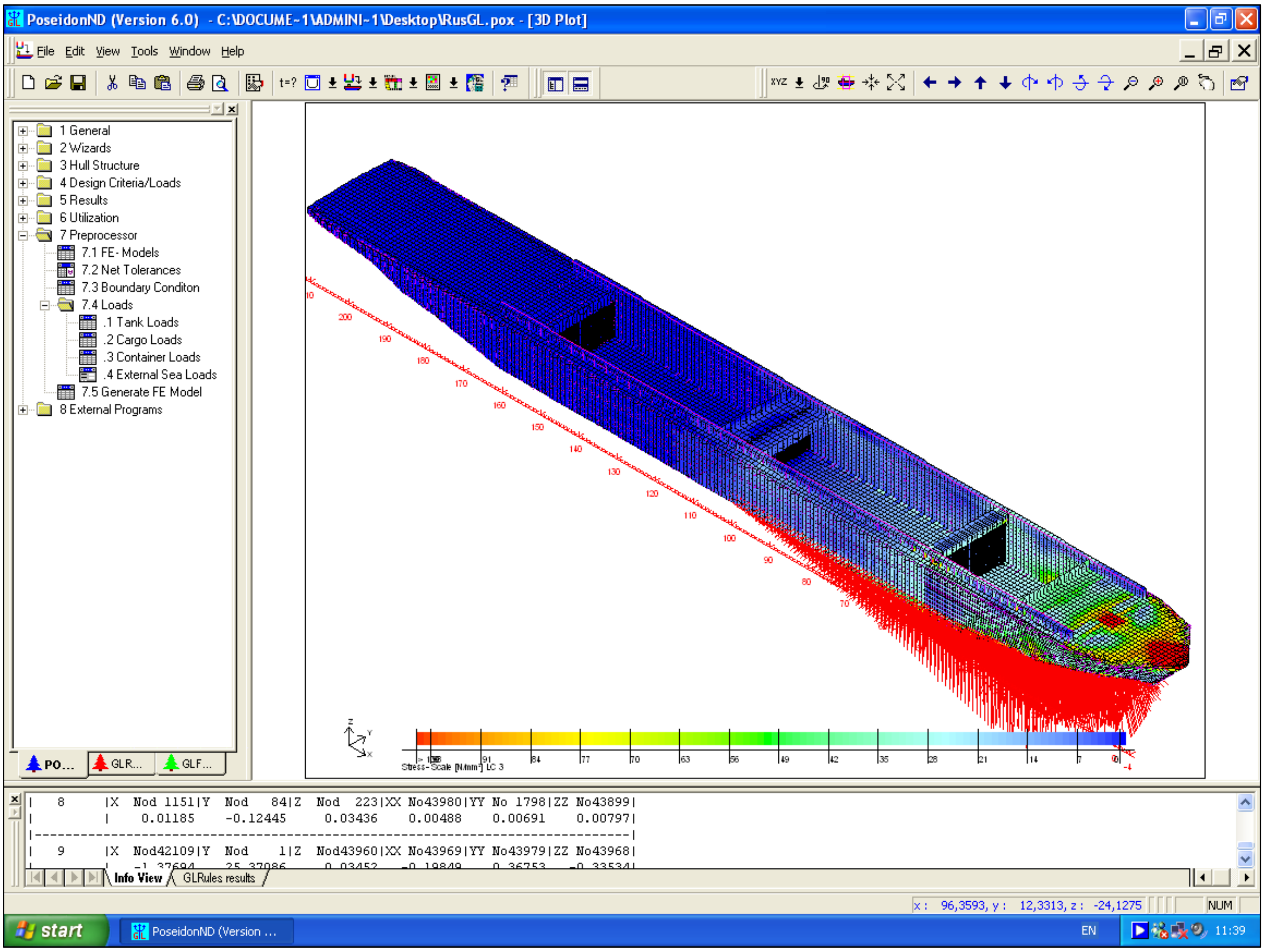


Source: [3]

Fig. 2 - Deformation of the ship bottom

It's harder to deal with composite structures due to the mechanical characteristics of the materials, but their desirable weight, performance and strength properties, offer dramatic opportunities for producing sea-going vessels. These materials make innovative new designs in the marine industry possible because they are more corrosion-resistant, durable and easier to maintain than metal structures.

However, the real potential for composites has not yet been realized largely because engineers face critical design and manufacturing risks when creating highly-engineered composite parts—such as design errors, high manufacturing costs and increased cycle times.



Source: [3]

Fig. 3 - Von Mises stress in consequence of slamming

To reduce these risks, more and more organizations are turning to specialized engineering software (for example: CompositePro, SysPly, Samcef, HyperSizer)to help them more efficiently, accurately and cost-effectively design and manufacture the most complex composite parts. Leading FEA suites can also work with composites very effectively but if you need simpler to use and lower cost software there is also some good alternatives.

When designing a mechanical system you need to understand how various components (pneumatics, hydraulics, electronics, and so on) interact as well as what forces (noise, vibration, and harshness) those components generate during operation. Some of the leading FEA suites have also very effective motion analysis modules for analyzing the complex behavior of mechanical assemblies. Computer software as Adams, Cosmos/Motion, WorkingModel3D allows you test virtual prototypes and optimize designs for performance, safety, and comfort, without having to build and test numerous physical prototypes.

2. CONCLUSION

The use of FEM has increased dramatically over the past few years. The increase is due to advances in computational methods together with the increase in performance and affordability of computers. The FEA became a very powerful tool that allowed design behavior investigation in real conditions, without expensive and time demanding prototyping. The use of these methods is still dependable on solid knowledge of structure behavior and of course knowledge of boundary conditions, to get actual results.

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