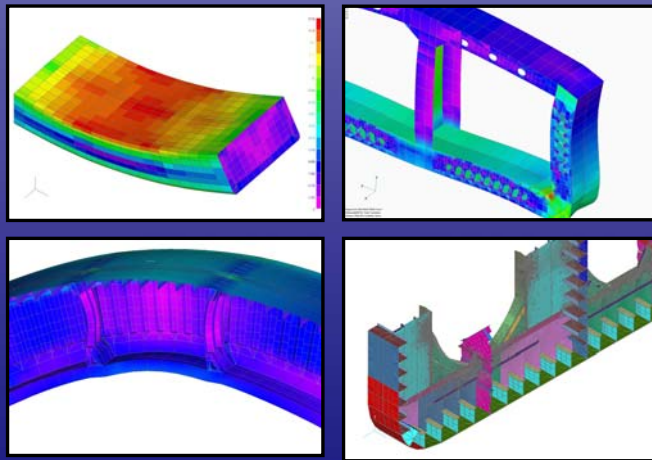
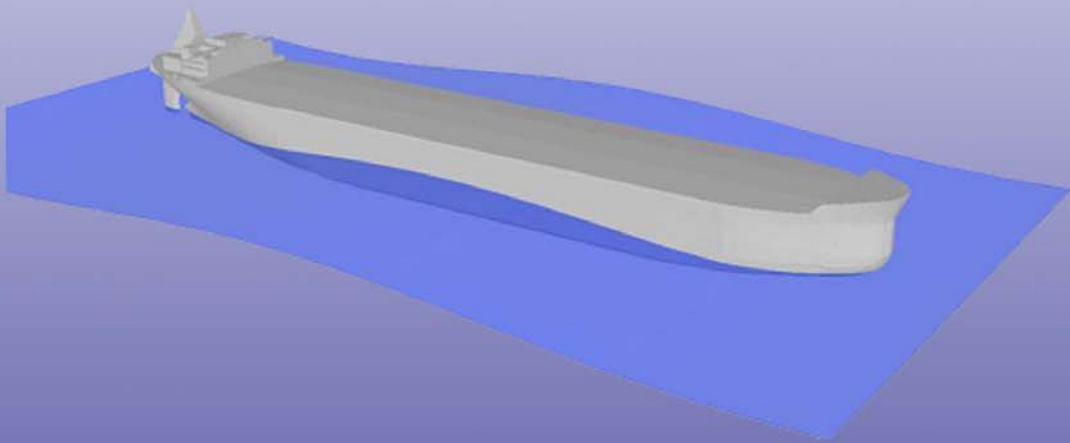


VIKING

S Y S T E M S

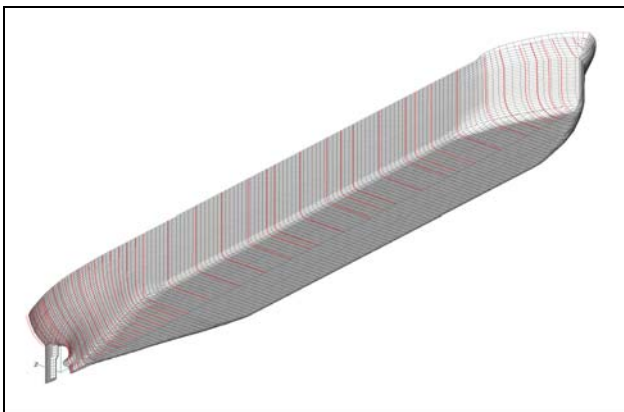


CONSULTING STRUCTURAL ENGINEERS

Modeling Capabilities

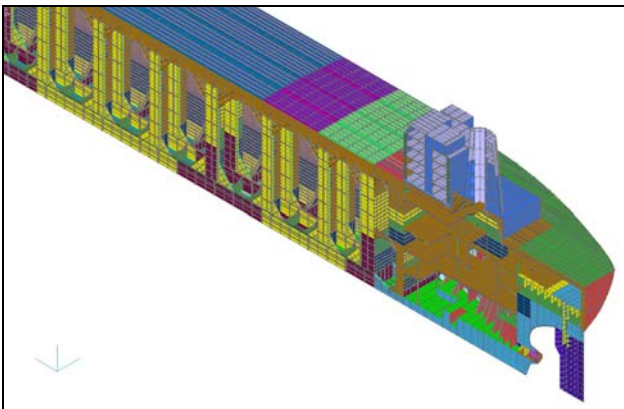
Viking Systems is the developer of SAGA Ships, our in-house software system that enables us to rapidly and accurately create structural finite element models. Structural modeling features of SAGA include:

- Automated shell mesh generation from hull offset tables, structural drawings or general arrangement drawings.



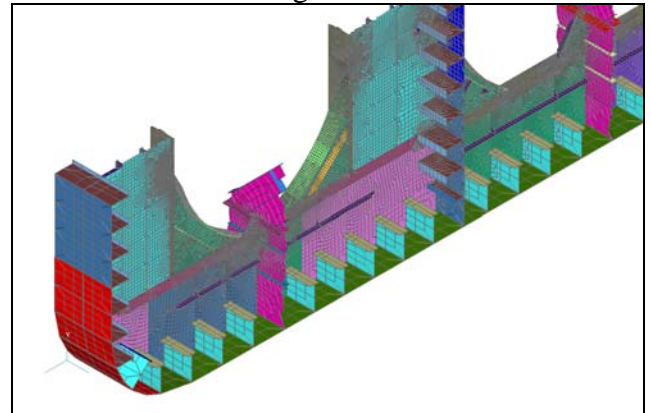
GLOBAL MODEL PRODUCED FROM OFFSETS WITH SAGA

- Automated deck and bulkhead mesh generation.
- Automated lumping of stiffener properties for coarse mesh global models



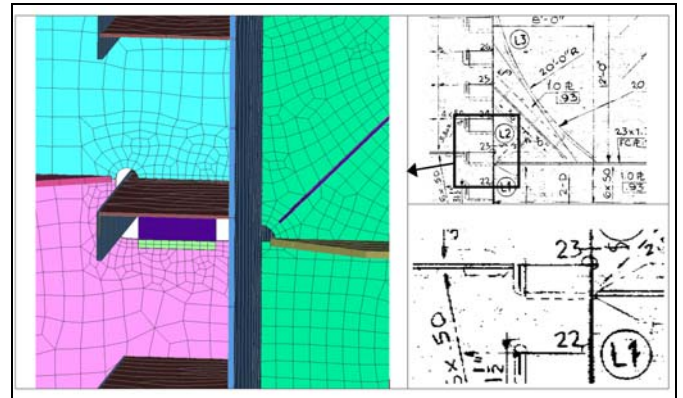
GLOBAL MODEL INTERNAL DETAIL

- Automated updating of beam properties to include attached plating for hybrid beam theory.
- Mesh refinement capabilities for local model generation
- Corrosion deduction regions allow for rapid corrosion modeling



LOCAL MODEL OF TRANSVERSE WEB FRAME

Viking Systems uses SAGA in combination with FEMAP and MSC/Nastran to create a wide range of both global and local models. Model size and mesh density is customized to meet the needs of the client and the requirements of the project.



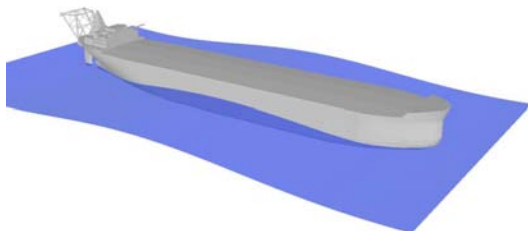
LOCAL MODEL OF COLLAR DETAIL

Ship Structural Design of FPSO and FSO Vessels

Viking Systems – a leading provider of structural design services - provides its clients with timely solutions using advanced analysis design tools and classification society requirements for ships and floating marine structures. Viking Systems has applied its extensive knowledge of structural design of ships to the development of SAGA, its proprietary structural engineering software.

Conversion Design and Classification:

Viking Systems performs analysis work related to conversion of single-skin tankers to FSO/FPSO Vessel. We perform analysis of structural finite element models of the entire vessel with the purpose of accurately verifying the proposed scantlings and to propose modifications to obtain a cost/schedule-effective design. We perform structural evaluation and verification to the rules of all major classification societies.



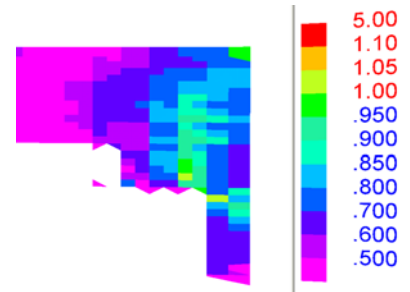
Hydrodynamic Loading

Loading Analysis:

Viking Systems software loads the vessel with required load components including wave loading, dynamic pressures, vessel accelerations, and tank loading.

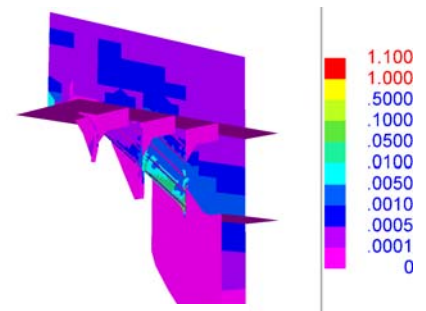
Stress Result Assessment:

Viking Systems' SAGA software is used to evaluate the structure of the vessel against classical yielding and buckling rules. The view on the right shows a bulkhead evaluated for a number of rules and a number of load cases.



Fatigue Analysis of Ship Structures

Viking Systems has implemented a methodology for fatigue evaluation of structural details. The method is based on long-term distribution of hull girder wave loading to produce a statistical stress spectrum via probability density functions. The system can also analyze a number of load cases resulting from a motion analysis. The results are presented as a stress damage ratio for each detail. The damage ratio results are processed to give a visual understanding:

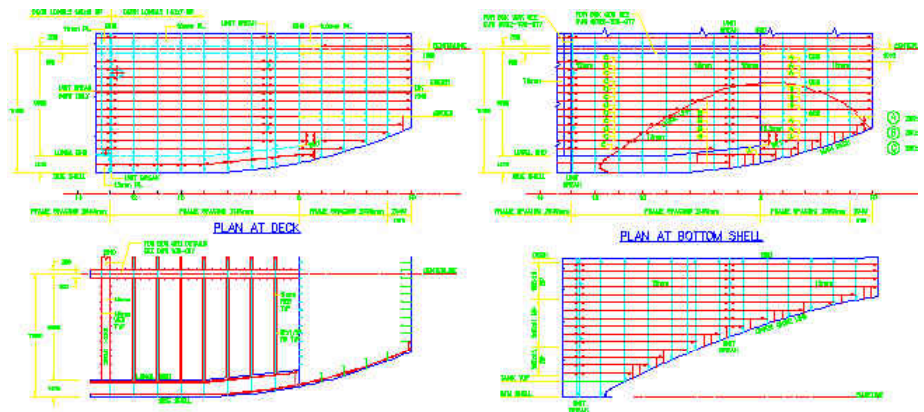


Ship Structural Design – Ocean Barges

Barge Structural Design

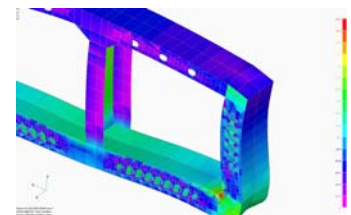
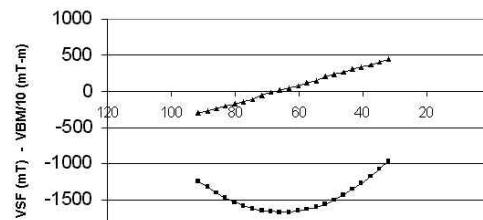
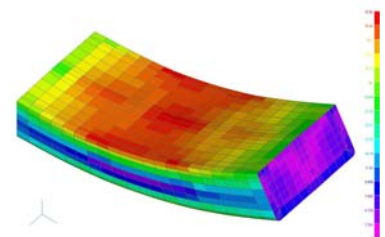
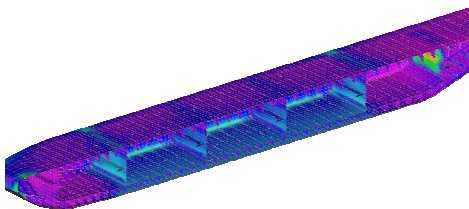
Design and Classification:

Viking Systems performs structural design and classification calculations of double-skin cargo barges for ocean and river routes. The design work includes scantling calculation according to classification society rules and delivery of complete structural drawings of the vessel to the shipyard.



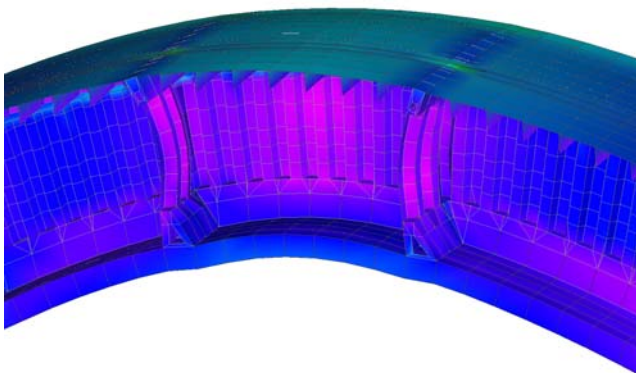
Longitudinal Strength and Thermal Analysis

Design Verification: Viking Systems carries out design of heated cargo barges. This type of design work involves thermal analysis of the heated cargo barge to verify the structure of the barge with respect to stresses resulting from thermal loading while subjected to still water and wave loading.



Ship Structural Design – ABS SafeHull Analysis

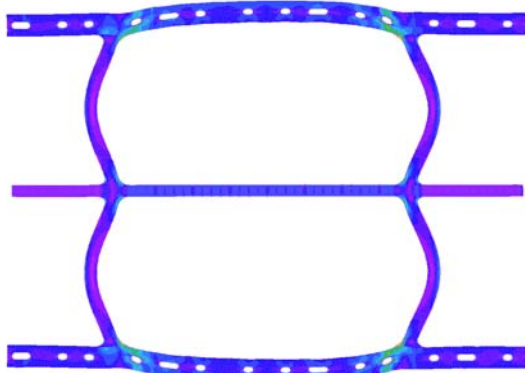
Phase B Global Structure Analysis



Viking Systems creates the global model using SAGA and MSC/Nastran modeling system for import into SafeHull Phase B for DLA loading, solving, and evaluation to ABS Rules.

Viking Systems uses SafeHull to evaluate the structure for yielding and buckling of panels as well as overall buckling of decks, tanktops, bulkheads, and bottom shell.

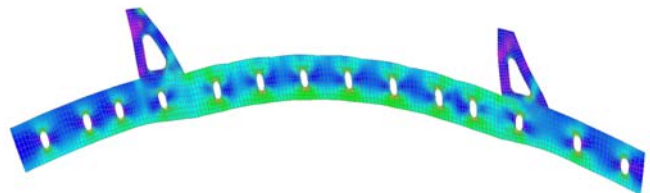
Horizontal Stringer Assessment



Stringer deformation due to dynamic loading.

Bottom Girder Assessment

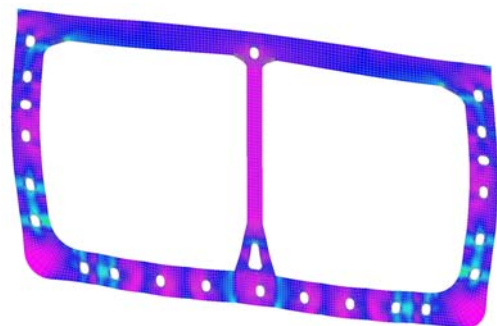
ABS requires local analyses of transverse frames, horizontal stringers, and bottom girders.



The local structural models include all openings for evaluation of opening stress. In addition these models are used for design of stiffeners, panel breakers and other local details

Transverse Frame Assessment

Viking Systems uses SafeHull 2-D frame analysis to verify the Phase A rule-based scantlings.



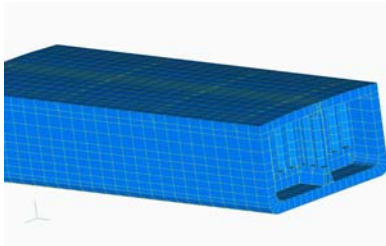
A detailed model is used to adequately assess the strength and fatigue characteristics throughout the transverse frame. In addition these models are used for design of stiffeners, panel breakers, and openings.

Ship Structural Software Development

Viking Systems has implemented its extensive knowledge of structural design of ships and floating structures into its computer program SAGA for Ships for analysis and classification verification solutions for ships and floating marine structures.

SAGA Structural Modeling

Viking Systems has developed a computer program SAGA to rapidly create structural finite element models based on hull offsets, structural drawings or general arrangement drawings. The methods works in 3D and 2D in combination with a ship coordinate system for assembly into a 3D structural finite element model. The program can also create a model without CAD drawings, by using a ship nodal description to create the majority of the regular ship structure. The modeling includes all structure, i.e. plates, beams, and stiffeners.

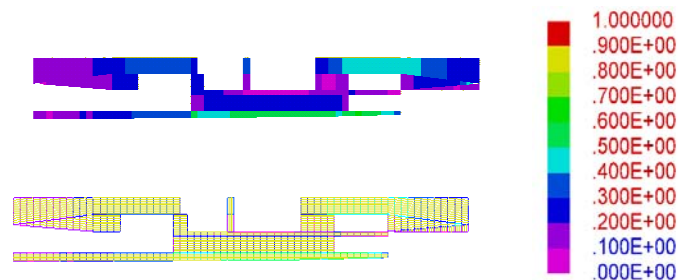


This modeling part of the program is typically used in combination with a Nastran capable finite element modeling system for creation of the additional detailed structure. SAGA maintains the plate stiffening system in terms of orientation, spacing and scantlings. The Nastran export feature determines the properties of beams using hybrid beam theory to represent the beam/plate interaction.

SAGA performs loading of structural finite element models with hydrostatic and hydrodynamic loads

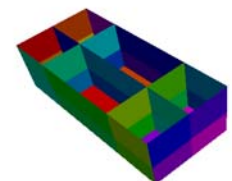
SAGA Structural Evaluation

Viking Systems has developed a feature in its SAGA computer program for evaluation of ship structures. This feature allows the model to be evaluated against a set of structural rules, such as those required by classification societies. This feature provides the designer an extremely reliable, rapid, and complete evaluation of a finite element model.



SAGA Structural Database and Graphics Systems

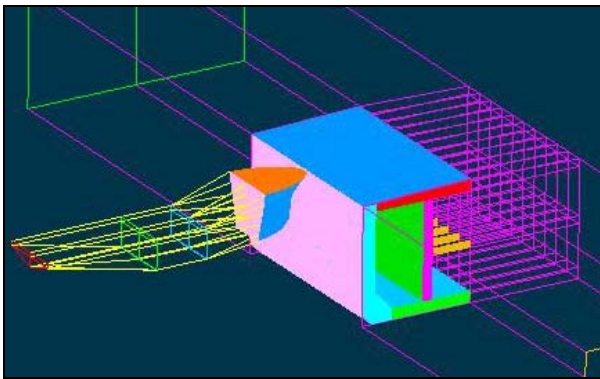
SAGA allows for assessment and graphical verification of any data present in the 3D ship model, and allows in addition user-defined database items. This feature assists in determining weight and areas by region. SAGA creates, loads, and evaluates the results of a finite element model.



Ship Collision Studies

Viking Systems has added LSDYNA to its in-house tools and is currently working with Dr. Alan Brown at Virginia Polytechnic Institute and State University to evaluate Ship Collisions.

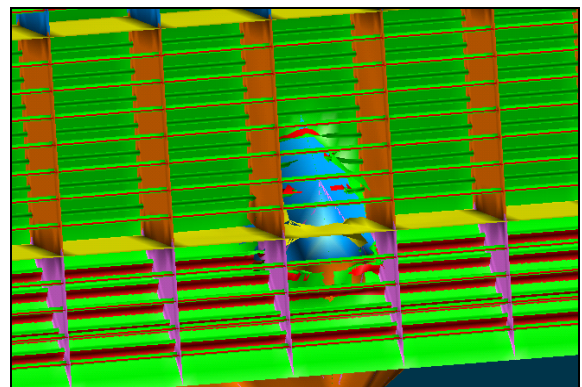
- A sweeping segment method is used to improve the calculation of damage volume and the direction of damage forces



COLLISION OF OFFSHORE SUPPLY VESSEL (OSV) WITH FPSO USING LSDYNA

Virginia Tech has developed Simplified Collision Model (SIMCOL) for calculating damage extent in ship collisions. Benefits of this program are:

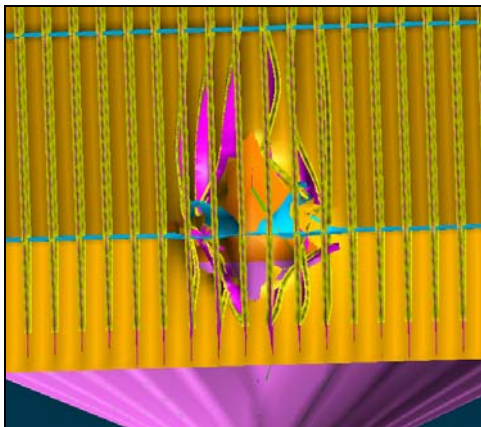
- Ability to rapidly perform probabilistic analyses



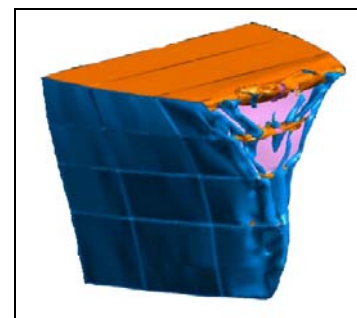
HORIZONTALLY STIFFENED STERN IMPACT – INTERNAL LOOKING AFT FROM FORWARD

- Ability to Evaluate Lateral deformation of web frames
- Ability to consider the vertical extent of the striking ship bow
- Ability to consider both rigid and deformable bows in the striking ship

In combination LSDYNA and SIMCOL gives us the ability to evaluate both Ship to Ship and Ship to Floating Structure efficiently and effectively.



VERTICALLY STIFFENED STERN IMPACT – INTERNAL LOOKING AFT FROM FORWARD



DEFORMABLE BOW