
**METHODOLOGY FOR OPTIMIZATION
OF SHELL STRUCTURES**

PS Associates

OBJECTIVES

- CAE & CAD of cylinder, cone isogrid & waffle shell structures
- Structure optimization
- Provide process visibility for user
- Provide facilities for user verification of analyses
- Generate complete design definition & drawings

EXPERT SYSTEM FEATURES

- Processes are primarily controlled by input specification
- Human intervention is minimized
- Internal structural loads are based on tailored or untailored structures
- Trades are automatically generated for human intervention guidance
- Analysis traces are provided for user visibility & verification
- Analytical element design definition parameters are automatically transformed into physical model

OVERALL SYSTEM



INTERNAL LOADS GENERATION I/O

- EXTERNAL SINUSOIDALLY DISTRIBUTED & POINT LOADS
- GEOMETRY
- SYMMETRY CONDITIONS
- ANALYTICAL ELEMENT SIZES
- SELECTION OF MAXIMUM OR AVERAGE LOAD PER ELEMENT
- PARAMETERS OF LONGITUDINAL MEMBER
- INITIAL SMEARED PLATE THICKNESS & YOUNG'S MODULUS
- REACTION AREAS & POINTS



- EXTERNAL REACTIONS
- FEM INPUT FILE

- SMEARED PLATE THICKNESS & YOUNG'S MODULUS FROM DETAILED SHELL ANALYSIS

- IN PLANE LOADS
 - TENSION
 - COMPRESSION
 - SHEAR

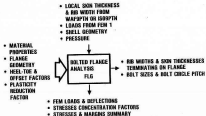
DETAILED SHELL ANALYSIS



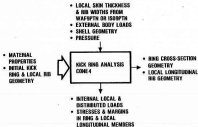
BOSS ANALYSIS



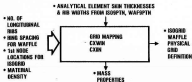
BOLTED FLANGE ANALYSIS



KICK RING ANALYSIS



ANALYTICAL-TO-PHYSICAL MODEL GRID MAPPING



FLAT PATTERN LAYOUT



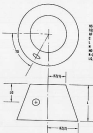
ISOGRID SHELL ANALYSIS ISO9PT1 OUTPUTS

ELEMENTS - SUMMARY OF SHELL DATA				ELEMENT TYPE		STATUS
NUMBER	AREA	PERCENT	PERCENT	ISOP	ISOT	REMARKS
	FEET	OF TOTAL	OF TOTAL			
01	1.0000			1	0	OK
02	1.0000	100%	100%	1	0	OK
03	1.0000	100%	100%	1	0	OK
04		0	0%	1	0	OK
05		0	0%	1	0	OK
06	1	100%	100%	1	0	OK
07	1.0000			1	0	OK
08	1.0000			1	0	OK
09	1.00	100	100	1	0	OK
10	1	100	100	1	0	OK
11	1	100	100	1	0	OK
12	1	100	100	1	0	OK
13	1	100	100	1	0	OK
14	1	100	100	1	0	OK
15	1	100	100	1	0	OK

***** SHELL SHEET SUMMARY *****
 SHEET NO. 1 OF 1 SHEETS

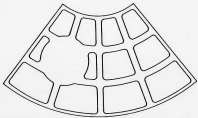
SHELL SHEET SUMMARY		SHELL SHEET SUMMARY		SHELL SHEET SUMMARY	
1	2	3	4	5	6
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2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000
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14	1.0000	1.0000	1.0000	1.0000	1.0000
15	1.0000	1.0000	1.0000	1.0000	1.0000

CVEX7 MENII MENU INPUT ITEMS



NO	PLAT PATTERN FILE NAME
SIZE, INCH	SMALL & LARGE CONE SIZE
NO	FLATTENING
T	HAUT AND WIDTH
L	CONE LENGTH
N	NUMBER OF RIDGE
NO	NUMBER OF STRONGER
R-D	RIDGE WIDTH
LC, NAME	RIDGE CORROSION

WAFFLE FLAT PATTERN LAYOUT



DESIGN SPECIFICATION SUMMARY

- SCOPE OF DESIGN CONTRIBUTION
- MATERIALS, FINISHES, ETC.
- EXTERNAL LOADS & WIND LOADS
- SOIL CONDITIONS
- BREEZING, LOGGERS & HOLES
- ARCHITECTURAL ELEMENTS/ FINISHES
- ARCHITECTURAL ELEMENTS/ FINISHES/ LOADS/ SYSTEMS
- EXISTING LIMITS & BLOCK DOWN LOADS
- REFERENCED CODES/ SECTION
- PROGRAM CASES & TOLERANCES
- INITIAL DESIGNING, MAXIMUM & MINIMUM TOLERANCES FOR
SIZES & PLACES/ TOLERANCES, THE WIDTH & NUMBER
OF CONNECTIONS, AND JOINTS OF STRUCTURES
- INITIAL AND END CONNECTIONS
- INITIAL CHECKS FOR CRACK WIDTHS ANALYSIS
- FINISH OPERATIONAL RESULTS OF ENVIRONMENT FOR
HOT AREA FOR
- SELECTIONS OF MATERIALS, RESISTANCE FOR DESIGN
CIR. ETC. TO BE USED IN STRUCTURAL DESIGN
- DETAILS FOR FRAMES & TRAYS
- END SPACING FOR WALLS IN PROVISION OF
FIRST WALLS IN CORNER
- RELATED PLANS/ CONFIGURATION
- INITIAL ESTIMATING COSTS
- ANALYSIS OF WINDS

SUMMARY

- Significant savings in cost & time-to-design
- System can be used as a model for many other expert systems
- Captures expert knowledge
- Can eliminate all or most human intervention
- Extremely user friendly
- Provides visibility, verifiability & accountability
- Outputs include stress analysis, mass properties reports & full documentation

CONCLUSION

- System is an implementation of a design for CAE & CAD philosophy
- Extension to design for CAM is also feasible