Sudan University of Science and Technology

College of Graduate studies

Analysis and Design of Silos Using Finite Elements

تحليل وتصميم صوامع الغلال بإستخدام العناصر المحددة

A Thesis Ssubmitted to Department of Construction Engineering College of Engineering in Partial Fulfillment of the Requirements For The Degree of Master of Science in Construction Engineering

By

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July 2018

الاية الكريمة:

بسم الله الرحمن الرحيم

قال تعالى :

(قُل لَّوْ كَانَ الْبَحْرُ مِدَادًا لِّكَلِمَاتِ رَبِّي لَنَفِدَ الْبَحْرُ قَبْلَ أَن تَنفَدَ كَلِمَاتُ رَبِّي وَلَوْ جِئْنَا بِمِثْلِهِ مَدَدًا)

صدق الله العظيم

سورة الكهف ، الآية (109)

Dedication:

To my:

Father’s Soul’’’’’’’’’’’’’’’’’’

Dear mother’’’’’’’’’’’’’’’’

Family’’’’’’’’’’’’’’’’’’’’’’’’’’

Friends’’’’’’’’’’’’’’’’’’’’’’’’

All people in my life

Acknowledgment:

I want to express my apperception and gratitude with recognition to supervisor:

Prof: Abdelrahman Elzubeir Mohamed

For his help and guidance doing this thesis by his invaluable advice with ultimate patience throughout thesis period.

Abstract

This research looks into the possibility of carrying out the analysis and design of reinforced concrete silos using the finite element method and SAP2000. Sean grain reinforced concrete silo was taken as case study. The research was based on conducting a review of literature published in the field of analysis and design of silos, including the required data and the methods used for analysis and design. A pre-designed silo, of 8m height, 4m diameter used to store cement was used to check the finite element model and to confirm the possibility of using SAP2000. The accuracy of results was verified by comparing with the published results. They were in close agreements with maximum difference not exceeding 9%. The reinforced concrete Sean grain wheat silo which is of 15m height and 22.5m diameter was analysed using a model of shell finite elements of SAP2000 program. The silo was also manually analysed and designed to compare results. The comparison showed close agreement of the results and the difference did not exceed 6%. The additional important results and information that can be obtained from the finite element model are indicated presenting samples of them.

التجريد

هذا البحث ينظر في امكانية اجراء تحليل وتصميم الصوامع الخرسانية باستخدام طريقة العناصر المحددة وبرنامج SAP2000 .اخذت صومعة سين للغلال من الخرسانة المسلحة كدراسة حالة .استند البحث علي اجراء مراجعة للدراسات التي نشرت في مجال تحليل وتصميم الصوامع متضمناً المعلومات المطلوبة وطرق التحليل والتصميم. تم استخدام صومعة مصممة مسبقا بارتفاع 8 متر وقطر 4 متر تستخدم لتخزين الاسمنت للتحقق من نموذج العنصر المحدد والتاكد من قابلية استخدام برنامج SAP2000 .تم التحقق من دقة النتائج عن طريق المقارنة مع النتيجة المنشورة وكانت النتائج متقاربة جدا حيث ان الفرق الاقصي لم يتعدى 9%. تم تحليل صومعة سين للغلال لتخزين القمح المصنوعة من الخرسانة المسلحة والتي يبلغ ارتفاعها 15متر وقطرها 22.5 متر باستخدام نموذج عنصر القشريات المحدد ببرنامج SAP2000. كما حللت وصممت الصومعة يدوياً لمقارنة النتائج واظهرت المقارنة ان النتائج متقاربة جدا حيث لم يتعدى الفرق 6%. استعرضت النتائج والمعلومات الهامة الاضافية التي يمكن الحصول عليها من نموذج العنصر المحدد وعرضت عينات منها.

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p_h	Horizontal pressure on silo wall
p_v	Vertical pressure
p_w	Vertical load transferred to the wall due to friction between stored material and silo wall
W	Bulk density of stored material
R	Hydraulic radius of silo or ratio of cross sectional area of fill material to perimeter of silo
µ	Coefficient of friction filling on filling
µ′	Coefficient of friction filling on concrete
E	Base on natural logarithms
H	Depth below the top of the silo to the point of which the pressure are being calculated
K	Ratio between horizontal and vertical pressure
Ø	Angle of repose of filling
Ø′	Angle of wall friction
A	Cross-sectional area of silo
U	Interior parameter of the silo
D	Diameter of silo
A_{st}	Area of steel
T	Hoop tension
F_y	Yield strength of reinforcement
d_{ei}	Displacement vector at node i
ui	Displacement in x direction
vi	Displacement in y direction
wi	Displacement in z direction
θxi	Rotation about x axis
θyi	Rotation about y axis

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction:

A silo is a structure in which granular material is stored. The term silo includes all forms of particulate solid storage structures that might otherwise be referred to as bin, hopper, grain tank or bunker. Silos may be circular or rectangular in shape and can be constructed of steel or reinforced concrete and may discharge by gravity flow or mechanical means. They can be supported on columns and load bearing skirts or they may be hung from floors.

The design of silo to store bulk solid involves bulk material properties, geometric and structural considerations. Bulk material properties consideration is important because the frictional and cohesive properties of bulk solid vary from one solid to another. A given bulk density can vary with change of particle size, moisture, temperature and consolidating pressure. This variability makes testing very important. When considering the geometric design of silo potential problems include arcing across an outlet, rattling through material and flow pattern during discharge.

The structural design of silo requires, among other things, knowledge of the distribution of pressure and shear stresses on its walls (caused by the stored material) and how the distribution varies during charging, storage at rest, discharge and recharging. Both the membrane stress and out of plane stress should be given due consideration in the design of silo walls and hoppers. Incidental stress and stress transmission at connection of shell and plates should be taken into consideration especially of group silos.

The analysis and design is usually carried out using Janssen’s theory or numerical methods. Numerical analysis and design of silo is best carried out using a finite element package such as SAP2000.

1.2 Statement of the research problem:

The complex nature of the loading that result from the stored material must be taken into account and this can be accurately done by using numerical methods such as finite elements.

The parameters of stored material properties include bulk density, angle of internal friction, angle of wall friction and pressure ratio which are the governing factors for the computing silo loads. This is easily taken into account in numerical methods.

The numerical results obtained have to be verified. The verification is to be based on comparison with known published results and results obtained using established manual methods.

1.3 Research Objectives:

1. To study all loads (pressure) resulting from stored materials and stresses acting on silo.
2. To study the use of computer programs for the analysis and design of silos.
3. To check the numerical silo model by comparison with known published solutions.
4. To analyse and design Sean grain reinforced concrete silo as case study using SAP2000.
5. To analyse, discuss and verify the accuracy of the analysis and design results.

1.4 Methodology:

The methodology includes the follow:

1. Collection of the information about silos (types, structural behaviour, method of analysis and design).
2. Choice of SAP2000 computer program and Sean grain silo as a case study.
3. Modelling and simulation of a known silo result with SAP2000 to verify the model.
4. Modelling and simulation of Sean grain reinforced concrete silo using the verified SAP2000 model.
5. Analysis and verification of the results obtained from model, drawing conclusions and presenting recommendations.

1.5 Outline of thesis:

The thesis is divided into six chapters; each chapter covers a certain area as follows:

Chapter one introduces the research subject and problem statement, presents its objectives, methodology and outlines of thesis.

Chapter two presents literature review that covers the historical background and the previous research reported in this field.

Chapter three presents the loads on silo and how to analyse and design silos manually and by SAP2000 program.

Chapter four is an application of SAP2000program on a circular reinforced concrete silo of known results and comparison of the results with known manual results.

Chapter five presents analysis and design of Sean grain silo manually and using SAP2000 and comparison of the analysis and design results.

Chapter six presents the conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction:

Silo has been used to store bulk solid in industries. The quantity may range from few tones to over hundred thousand tones. Shallow bins are usually called as bunker and deep bins are usually called as silo. If the plane of rupture of material stored meets the top horizontal surface, the common name of silo is bin. Reinforced concrete bins are preferred to steel bins. Silo may be circular or rectangular in shape.

2.2 Historical Background:

2.2.1 Types of silos:

According to Dinue (2014) there are three types of silos as follows:

a- Flat bottom silos:

This type of silos shown in Figure (2.1), is used for long term storage of large quantities of grain, seeds and granular products.

Fig (2.1): Flat bottom silo, Dinue (2014)

b- Hopper silos:

These hopper silos are used for storage of grains (cereals, seeds, legumes, industrial products and other products) that require special storage condition. This type of silos is shown in Figure (2.2).

products. The truck load silo is shown in Figure (2.3).

Fig (2.2): Hopper silo, Dinue (2014)

c- Truck load silos:

These types of silos are used for storage and subsequent delivery of bulk products. The truck load silo is shown in Figure (2.3).

Fig (2.3): Truck load silo, Dinue (2014)

2.2.2 Failure of silos:

According to Carson and Jenky (1993) and Dinue (2014) the major cases of silo failure are due to shortcoming in one or more of four categories as follows:

a- Failure due to design:

Silo design requires specialized knowledge; the designer must first establish the material's flow properties then consider such items as flow change geometry, flow static pressure development and dynamic effects. Problems like ratholing and vibration have to be prevented while assuring reliable discharge of required rate.

Non uniform loads, thermal loads and the effects of non-standard fabrication details must be consider above all the designer must know when to cautious in the face of in complete or misleading information or recommendations that come from handbook.

Having established the design criteria a competent design has to follow, here the designer must have a full appreciation of load combination, load path, primary and secondary effects of structural elements and the relative flexibility of element. Special attention must be given to how the most critical details in the structure will be constructed so the full requirement and intent of the design will be realized.

Failure on grain silo according to wrong design is presented in Figure (2.4) and failure as a result of mass flow developing on silo design structurally for funnel flow is shown in Figure (2.5).

Fig (2.4): Failure of grain silo, Dinue (2014)

Fig (2.5): Result of mass flow developing in a silo design structurally for funnel flow, Dinue (2014)

b- Failure due to construction errors:

In the construction phase there are two ways in which problems can be created; the more common of these is poor workmanship, uneven foundation settlement and faulty construction (such as using the wrong materials or not using adequate reinforcement for example insufficient quantity of rebar) are but two examples of such a problem This can usually be avoided by hiring only qualified builders by close inspection during construction and by enforcing a tightly written specification.

The other cause of construction problems is the introduction of badly chosen or even unauthorized changes during construction in order to expedite the work. Any change in details, material specifications or erection procedure must be given careful consideration by both the builder and silo designer.

c- Failure due to usage:

If a bulk material other than the one for which the silo was designed is placed in it, the flow pattern and loads may be completely different. The load distribution can radically change if alterations to the out let geometry are made.

The designer should be consulted regarding the effects of such changes before they are implemented, some of the problems which can occur include:

- Collapse of large voids, a collapsing arch or rathole induces tremendous dynamic loads on the structure which can cause the structure to fail. Vibrating bin discharges have also been known to fall off bins and silos because of this mechanism.
- Development of mass flow in silos designed structurally for funnel flow. Mass flow can develop if the wall becomes smoother with time or if the properties of bulk solid being stored change, this generally results in much higher loads at the top of the hopper which can result in structure failure. Flow problems are shown in Figures (2.6) and (2.7).
- Drastic means of flow promotion, high pressure air cannons and even dynamite are sometimes used to restore flow, the result may be more dramatic than the user designer anticipated.

- Buckling of unsupported wall below an arch of stored bulk material.
- Metal fatigue caused by externally mounted bin vibrators.
- Dust explosions.

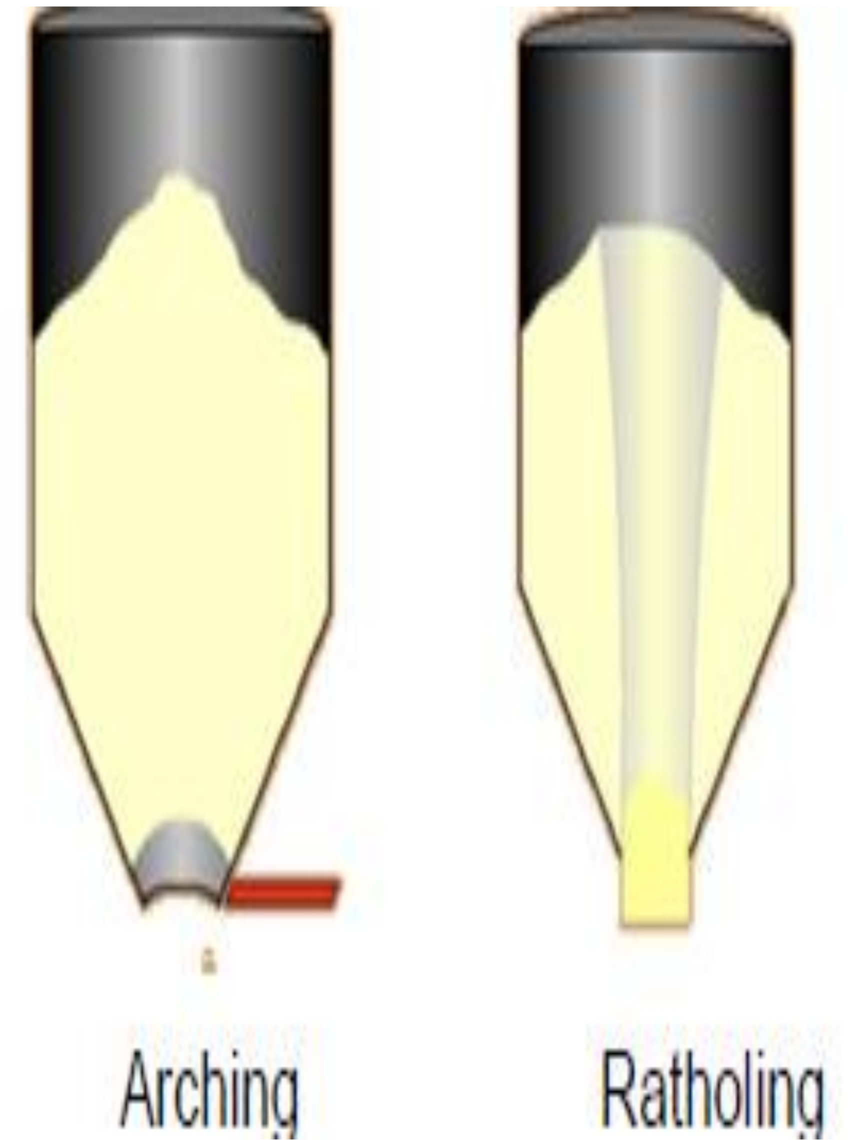


Fig (2.6): Flow problem experienced in improperly designed, Dinue (2014)

Fig (2.7): Damage to upper part of silo due to flow problem, Dinue (2014)

d- Failure due to improper maintenance:

Maintenance of a silo come in the owner's or user's domain and must not be neglected. There are two types of maintenance work required. The first is the regular preventative work. The second area of maintenance involves looking for signs of distress, (e.g., cracks, wall distortion, tilting of structure) and reacting them.

2.3 Previous studies:

Chaijareonswad (1974) discussed manual analysis of circular grain silo with the height of 150 ft. The required storage of the silo was 480560 cubic feet of wheat with angle of repose 28 degree. The diameter of silo is 80 ft. The paper discussed calculating horizontal pressure on 15 layers every layer has a height of 10 ft using Janssen's theory. The maximum pressure was 731b/ft^2 on the last layer. For design the paper discussed the use of allowable unit stress theory for the design of silo wall which calculate horizontal reinforcement by dividing tension by allowable reinforcement steel stress. The reinforcement on wall was #7 bars @5.5 in.

Tomas (2013) described silo and bunker design for reliable flow of cohesive powder and discussed the flow of particulate solid in bunker and the different between funnel and mass flow and properties and simulation with particle properties. The paper discussed the types of flow of particles solids in silo and flow problems as shown in Figure (2.8). The paper also described the simulation with particles different types of flow as shown in Figure (2.9).

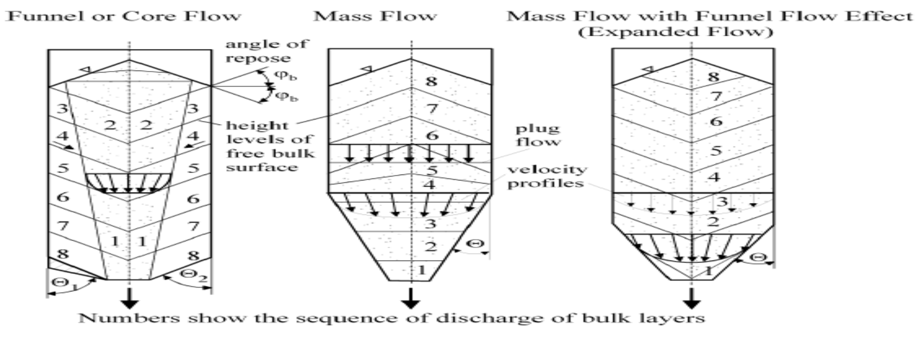


Fig (2.8): Type of flow on silo and flow problem, Tomas (2013)

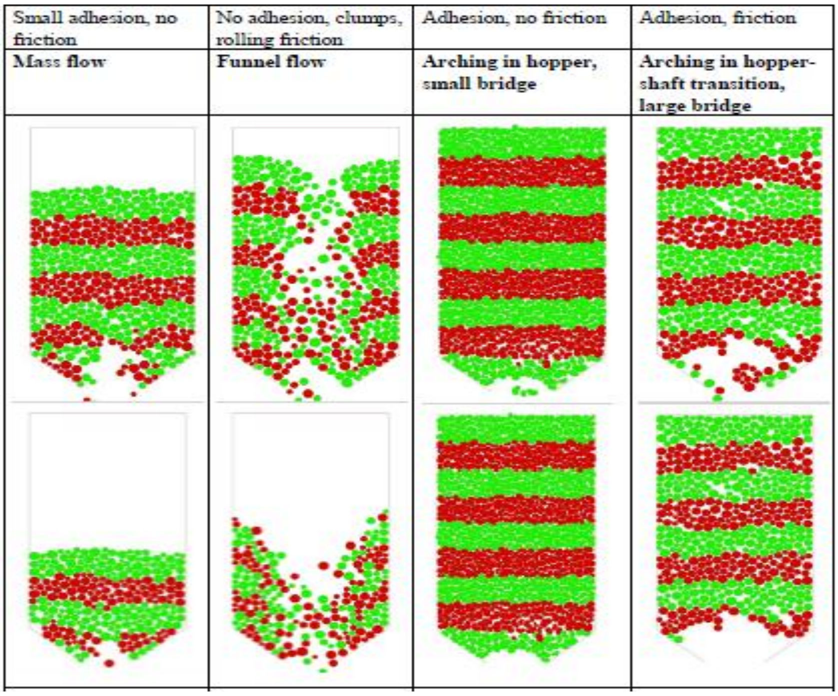


Fig (2.9): simulation with particle properties on different type of flow, Tomas (2013)

Pambhar and Vaniya (2015) discussed the comparison between manual result of analysis and design of silo and NET program result. The silo was reinforced concrete circular silo and the storage material was cement with density 15.5kN/m^3 and angle of friction 25 degree. The silo has a height of 8 m and a diameter of 4m. The manual result was obtained by Janssen's theory by dividing the silo to 8 layers every layer has a height of 1m. The maximum hoop tension was 51884N in the last layer. For design the paper was used allowable unit stress theory and the maximum area of steel was 225.58 mm^2 in the last layer. For the NET program the maximum hoop tension was 51299.1N in the last layer and the maximum area of steel was 223.04 mm^2 in the same layer.

Ansari, Armaghan and Kulkarni (2016) described design and optimization of reinforced concrete circular silo according to economic considerations. The silo was reinforced concrete circular silo and the storage material was coal with density 8kN/m^3 and angle of repose was35 degree. The silo diameter was 4.2 m, height of cylindrical portion was 8.35m and depth of hopper bottom was 1.85m. Janssen's theory was used to calculated horizontal pressure on three layers. The first layer has depth of 5m from the top and horizontal pressure 7.45kN/m^2, the second layer has depth of 8.35 from the top and horizontal pressure 10.159 kN/m^2 and the third layer has depth of 10.2 from the top and horizontal pressure 11.116kN/m^2. For the third layer the hoop tension was 23.343kN and the area of steel was 96.98mm^2. The bars used were 8mm at 300mm centre to centre.

Bradley and Farnis discussed design of silo for reliable gravity flow and the problem of unreliable or irregular flow which that unlike liquids, powder support shear stress when at rest. Many powder and bulk solid also have a property known as cohesion which means that after they have been subjected to pressure they can retain increased strength. They also mentioned that as a result many hoppers plant of all sizes and all industries suffer from damage hammering, popularly known as hammer rash as shown in Figure (2.10).

Fig (2.10): Hammer rash on bins with flow problems

CHAPTER THREE

LOADS ON SILO AND METHOD OF ANALYSIS AND DESIGN

3.1Introduction:

The quantity of the material storage on silo may range from few tones to over of hundred thousand tones.

The silos are always provided with hopper bottoms, the slope of hopper bottoms with horizontal is kept more than angle of friction between the grain stored and concrete so that when bottom door is opened the material start rolling down on its own weight, the silos are supported on a number of columns spaced at regular intervals, the distance between two adjacent column and high of column should be sufficient for a truck to pass, so that can be directly loaded with material stored when hopper bottom is opened.

The static pressure of the material inside the silo pressing out ward on the stave increases toward the bottom of the silo, so the hoops can be spaced wide apart near the top but become progressively more closely toward the bottom to prevent seams from opening.

Silo loads from stored material have many shapes acting on silo. Jansen's theory and rational method are manual methods for analyse and design silos.

SAP2000 program is a computer program as an application of the finite method use to analyse silos.

3.2 Loads:

There are three types of loads caused by a stored material inside the silo they are:

- Horizontal load or horizontal pressure (p_h) acting on the side walls.
- Vertical loads or vertical pressure (p_v) acting on the cross sectional area of the silo filling.
- Frictional wall loads or frictional wall pressure (p_w) introduced in to the side wall through wall friction.

The loads considered in silo are dead load, live load and wind load. There are many actions on silos like:

- The active earth pressure.
- Temperature variation: thermal contraction of bin wall is restrained by the stored material.
- Consolidation: consolidation of the stored material may occur to release of air causing particles to compact the accurate determination of wall pressure requires knowledge of variation with depth of bulk density and the angle of internal friction.
- Moisture content: an increase in the moisture content of the stored material can increase cohesive force, the angle of wall friction for pressure calculation should be determined using both the driest and wettest material likely to be encountered.
- Segregation: for the stored material with wide range of density, size and shape the particle tend to segregate. The segregation patterns are shown in Figure (3.1)

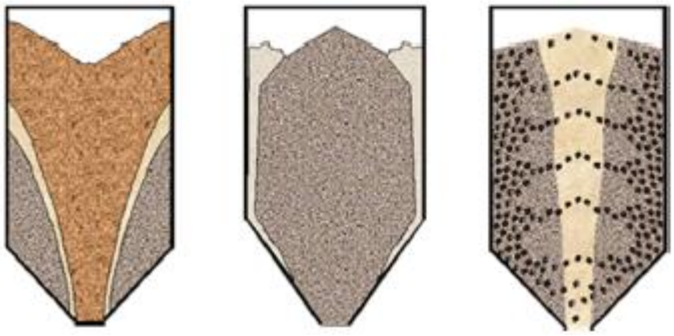


Fig (3.1): Segregation pattern due to different mechanisms, Dinue (2014)

- Degradation: this problem is storage of silage where material degradation may result in changing pressure field which tend to hydrostatic.
- Corrosion: stored material may attack the storage structure chemically, the design wall thickness may be increased to allow for corrosion and increase depends upon the design life of bin.
- Impact pressure: the changing of large rocks can lead to high impact pressure in this case a preventative solution is required at the geometric design stage.
- Differential settlement: may lead to buckling failure of membrane steel bins.
- Mechanical discharge equipment: can lead to unsymmetrical pressure distributions even when it is considered to withdraw the stored material uniformly.
- Roof load: roof bin impose an out ward thrust and axial compression on bin walls and should be considered during wall design.

3.3 Janssen's theory:

Traditionally silos design has been based on Janssen's theory with the introduction of an increased factor of safety to cover the lack of knowledge of an actual un loading pressure where stored material are sensitive to moisture the serviceability limit state needs particular attention, especially with circular silos where the wall is subjected to hoop tension.

The walls of silo are designed to resist bending moment and tension caused by pressure of contained material.

The most common basis for design of silo is the theory of Janssen, the horizontal load p_h at depth h below the free surface being related to material parameter k by the equation as shown in the equation (3.1) to (3.6).

$$p_h = \frac{WR}{\mu'} (1- e^{-\mu' * k * h/R}) \quad (3.1)$$

In Janssen's derivation: $k = \frac{1-sin\emptyset}{1+sin\emptyset}$ (3.2)

$$R= \frac{A}{U} \quad (3.3)$$

$$A= \frac{\pi D^2}{4} \quad (3.4)$$

U= Πd (3.5)

μ' = tanØ` (3.6)

Hoop tension calculates by equation (3.7): T = p_h * D/2 (3.7)

3.4 Numerical Method:

The derivation of the numerical solution of the problem by finite element method starts from the conversion of stress equilibrium from local description to a global integral form. Then the global integral equations are discretized by a finite number of elements.

In the problem of thin shell analysis the displacement may be defined with respect to meridional direction and circumferenial direction.

The generalized displacement vectors for the element are defined by the equation (3.8):

$$d_e = \begin{Bmatrix} d_{e1} \\ d_{e2} \\ d_{e3} \\ d_{e4} \end{Bmatrix} \quad (3.8)$$

The displacement vector at node is defined by equation (3.9):

$$d_{ei} = \begin{Bmatrix} ui \\ vi \\ wi \\ \theta xi \\ \theta yi \end{Bmatrix} \quad (3.9)$$

The shell element stresses are the force- per unit area act with the volume of the element to resist the loading. The stresses are:

- In plane direct stresses (S11and S22).
- In plane shear stresses (S12).
- Transverse shear stresses (S13 and S23).
- Transverse direct stresses (S33) which always assumed to be zero.

The thin shell neglects transverse shearing deformation. The thin shell element shape and the axis shown in figure (3.2)

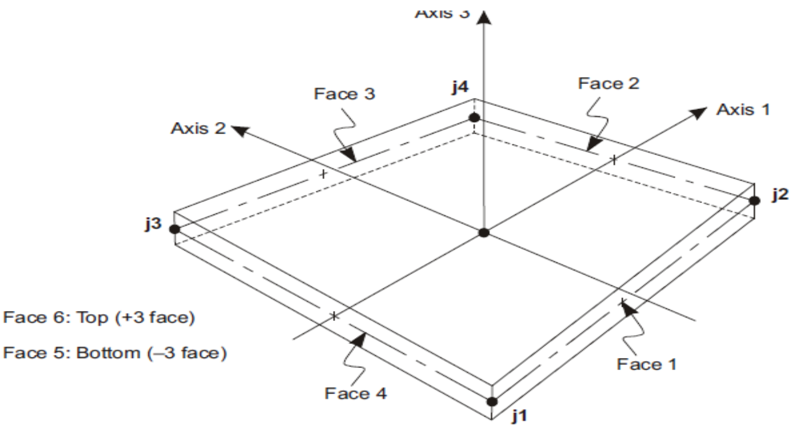


Figure (3.2) Thin shell element

3.5 Silo design:

The design of bins and silos to store bulk solids involves bulk material geometric and structural consideration. Bulk material properties considerations are important because the frictional and cohesive properties of bulk solid vary from on solid to another and these properties affect material behaviour considerably. When considering the geometric design of silo potential problems include arching across out let, ratholing through the material and the flow pattern during discharge. Established design procedures include selection of optimum hopper angle and minimum out let dimensions.

3.5.1 Design checks:

- Global stability and static equilibrium.
- Strength of the structure and joint.
- Stability.
- Cyclic plasticity.
- Fatigue.
- Deflection.

3.5.2 Design parameters:

Design parameters of stored material include bulk density, angle of internal friction, angle of wall friction and pressure ratio. Storage and flow characteristic of granular materials differ widely from those of powdery materials.

3.5.3 Design criteria:

General requirement of working stress method: provision shall be made for condition stresses that may occur in accordance with principles of mechanics, recognized method of design and sound engineering practice.

In particular adequate consideration shall be given to the effect of monolithic construction in the assessment of the bending moment and shear force. The area of steel calculates by the equation (3.10):

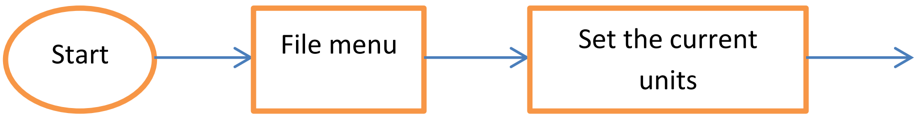
$$Ast = \frac{F_t}{0.87*f_y} \qquad (3.10)$$

3.6 Analysis and Design by SAP2000:

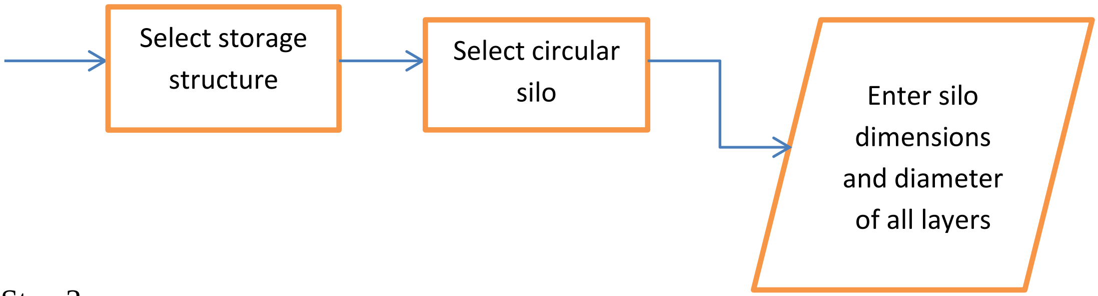
SAP2000 means Structural Analysis Program, to make model on SAP2000 anything must be fixed from inputs, meaning that material properties, boundary condition, etc.

3.6.1 Modelling on SAP2000:

Step1:



Step 2:



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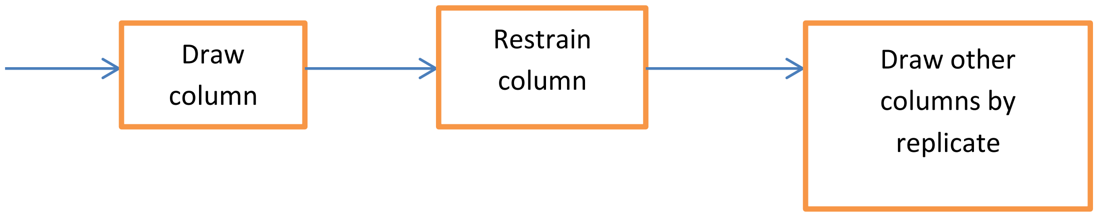
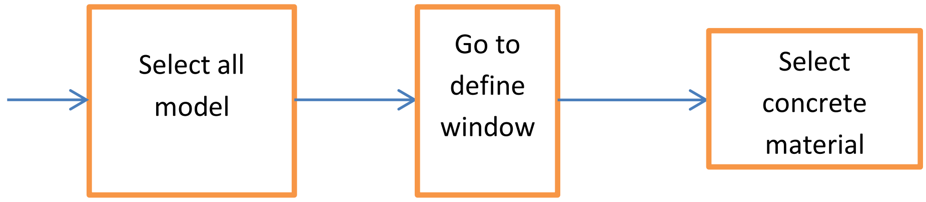
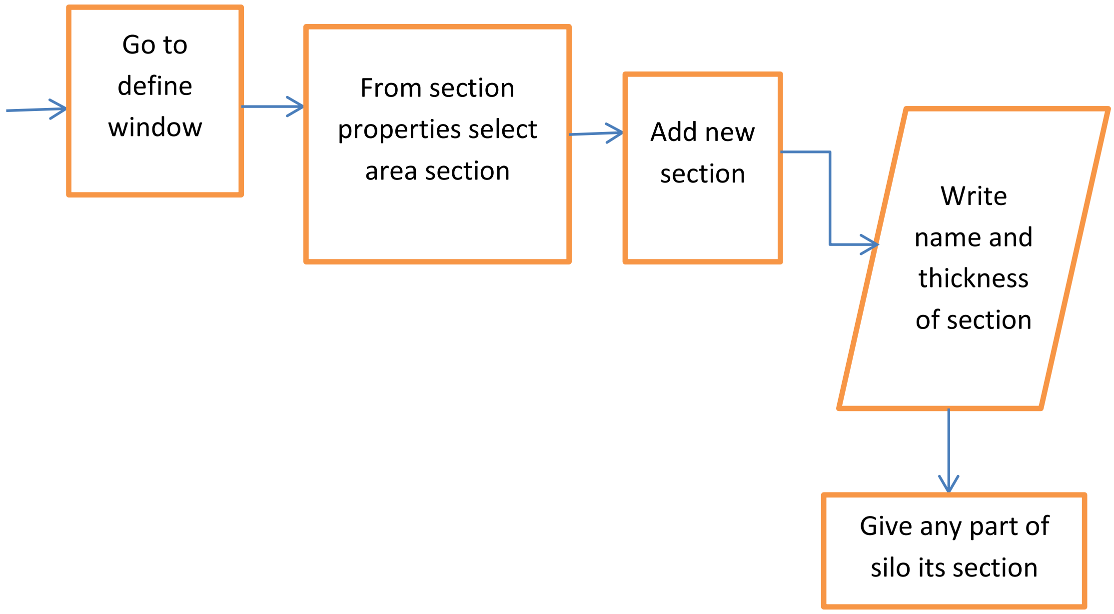


3.6.2 Material defines:



3.6.3 Section definition:

Step 1:



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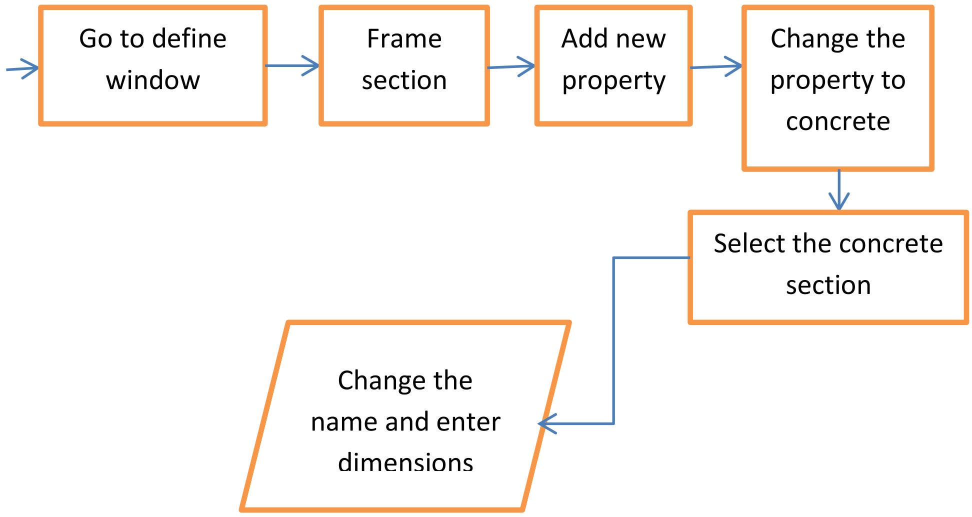

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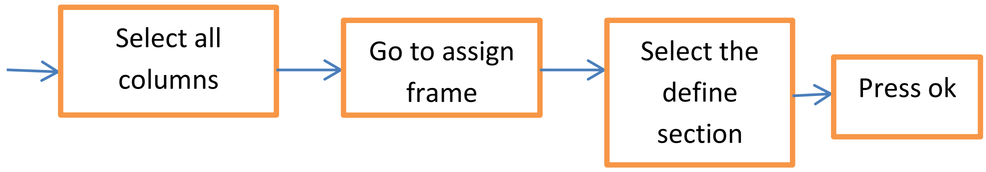
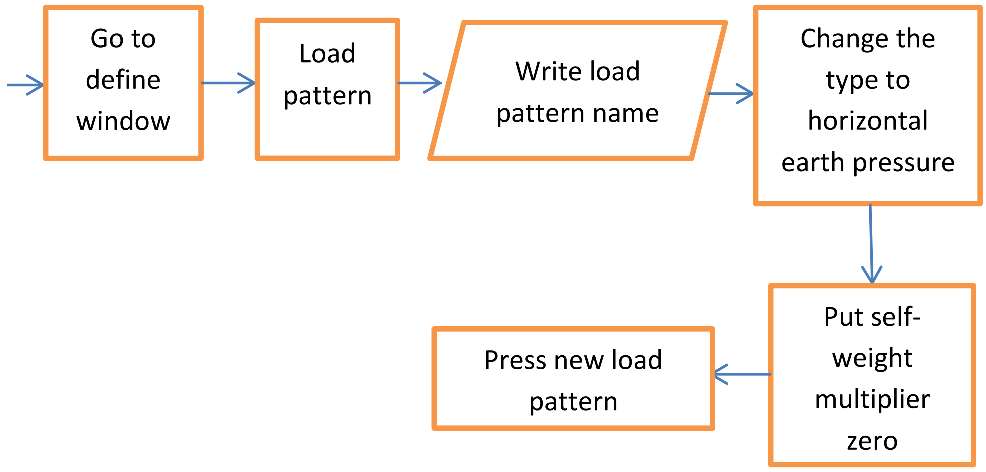


3.6.4 Loading:

Step 1:



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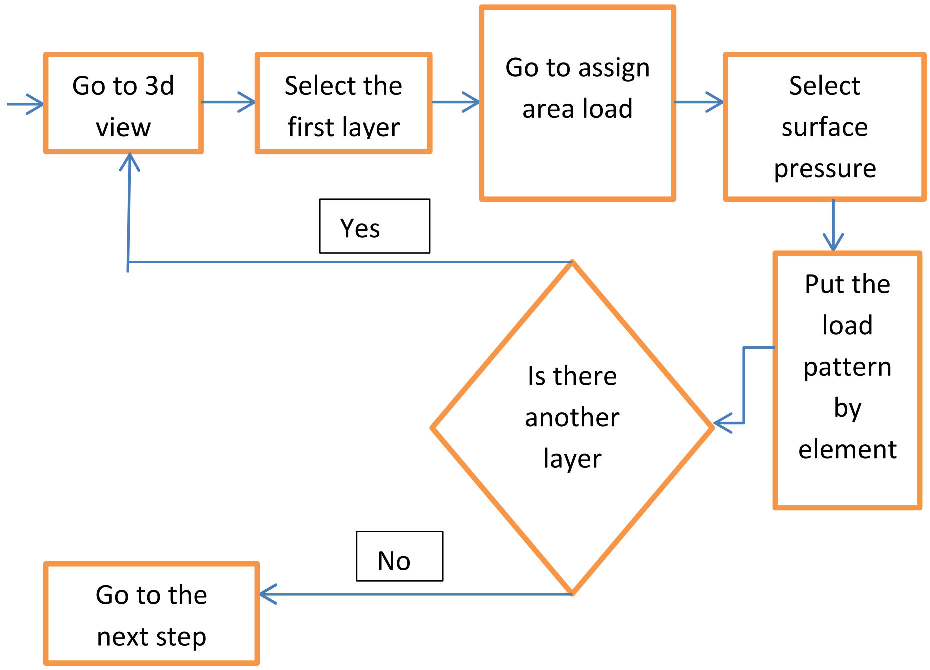
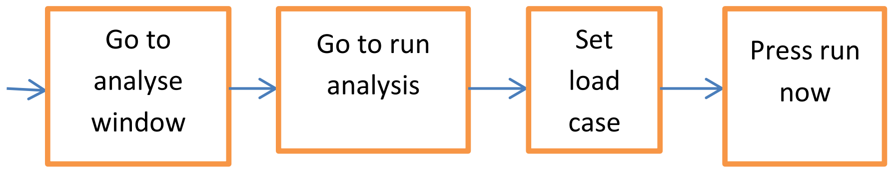
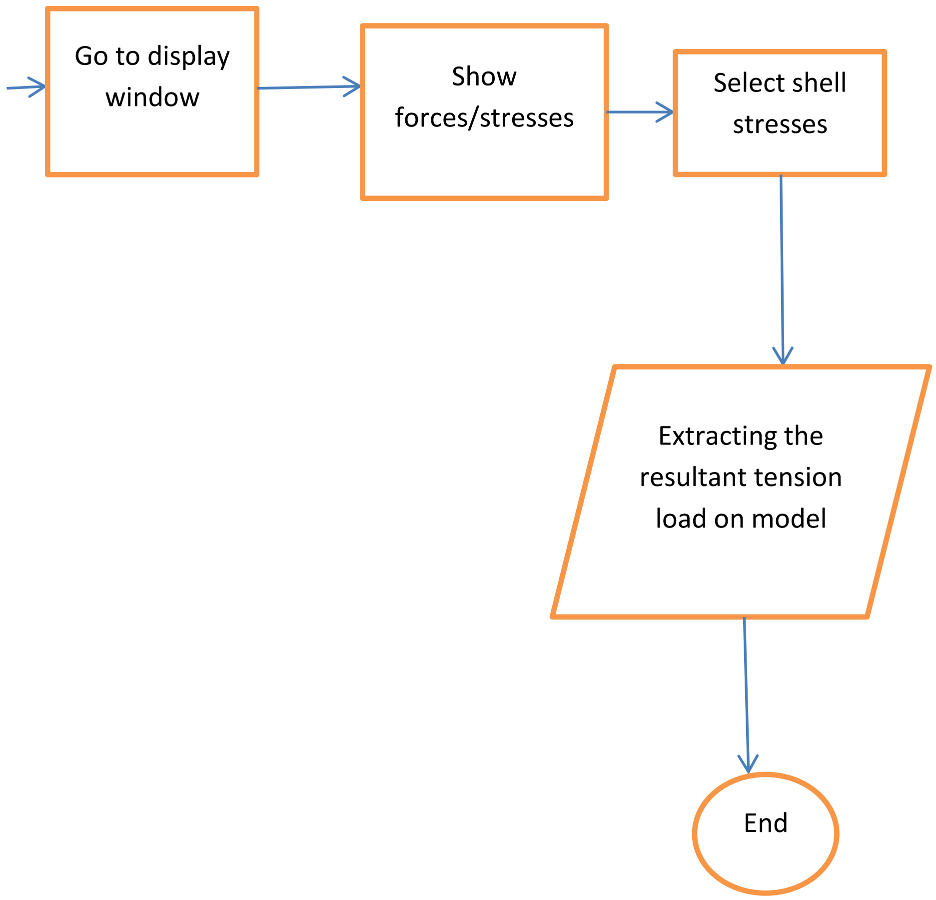


3.6.5 Analysis:



3.6.6 Extracting results:



CHAPTER FOUR

ANALYSIS AND DESIGN OF MODEL CIRCULAR SILO

4.1 Introduction:

SAP2000 program is used for analysis and design of a circular silo. The analysis and design results are compared with the published manual results, Pambhar and Vaniya (2015).

The silo is circular concrete silo having a height of 8m and a diameter of 4m. The stored material is cement with capacity 50 tones. The density of granular material is 15.5 KN/m^2. The angle of internal friction is 25 degree (Appendix A) and the angle of wall friction is 25 degree (Appendix A). The sections of the circular silo are roof sections with thickness 0.28m, the main silo section with thickness 0.28 m, the hopper section with thickness 0.25m and column section with diameter 0.4m.

The conical hopper bottom slope is 45 degree, opening at the bottom is 500mm and hopper height is 3m.

4.2 Pressure calculations:

According to equation (3.2): K= $\frac{1-\sin 25}{1+sin25}$ = 0.405

According to equation (3.4): A = π (16)/4 = 12.5m^2

According to equation (3.5): U = π (4) = 12.5

According to equation (3.3): R =12.5/12.5=1

According to equation (3.6): μ′ = tan25=0.466

Using this relations and equation (3.1), the pressure various depth was calculated and is presented in Table (4.1)

Table (4.1) pressure calculation of circular silo with Janssen's theory

Height (m)	Ph (kN/m^2)
1	5.456
2	10.059
3	13.942
4	17.219
5	19.983
6	22.315
7	24.252
8	25.942

4.3 Modelling of Silo:

4.3.1 Silo model:

The model start by choosing circular silo with a diameter of 4m and eight layers every layer have a height of 1m and the hopper with diameter 0.5 m with height 3m, the element use in the model is shell element. The model of circular silo is presented in Figure (4.1).

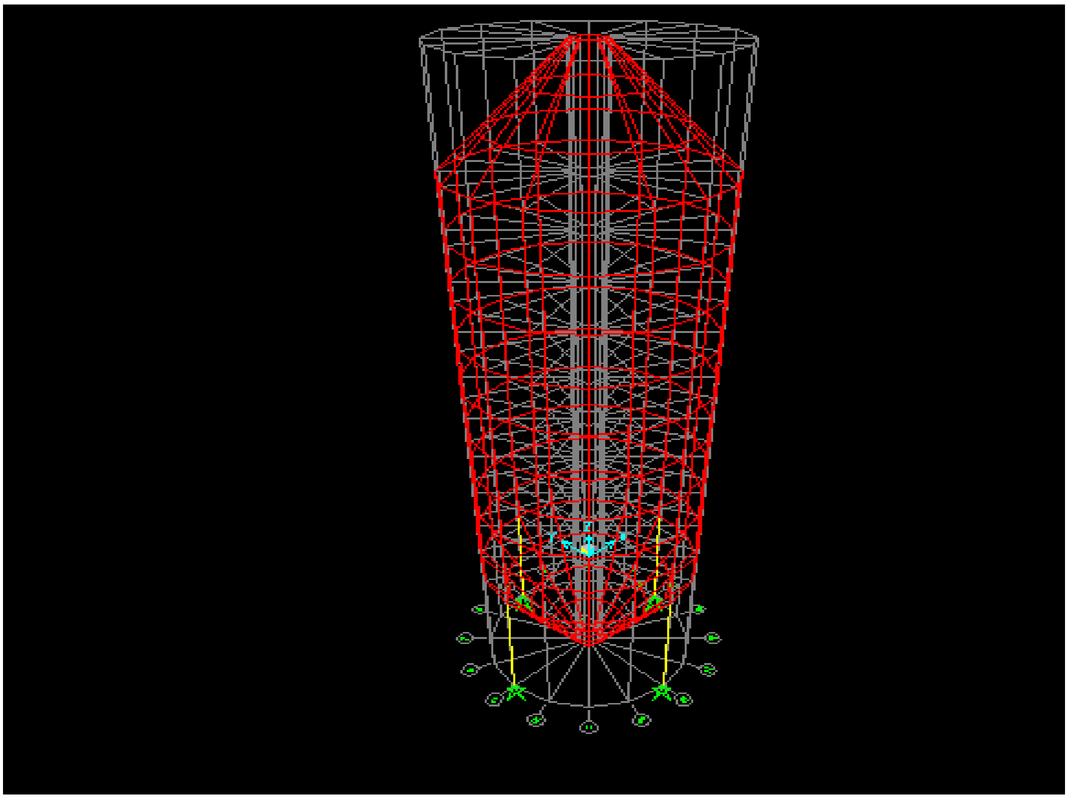


Fig (4.1): Circular silo model

4.3.2 Material definition:

The material of circular silo is reinforced concrete on SAP2000 as shown in Figure (4.2).

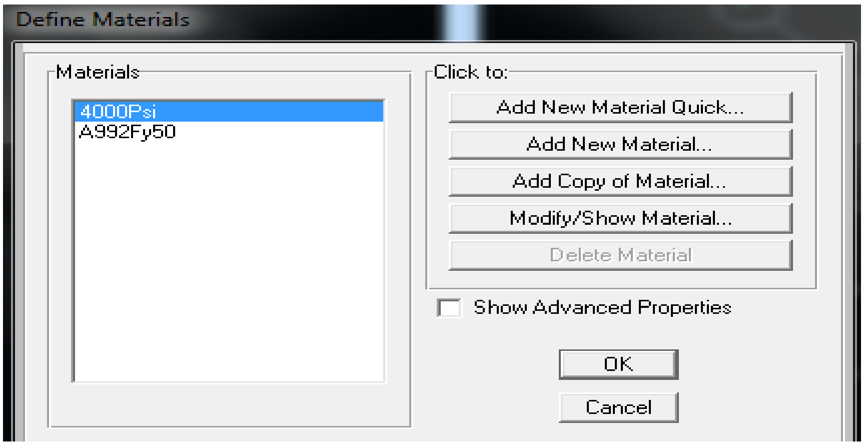


Fig (4.2): Material define of circular silo

4.3.3 Sections definition:

The silo divided in to three sections which are roof section, main silo section and hopper section. This section definition was shown in Figure (4.3). And the column section was shown in Figure (4.4).

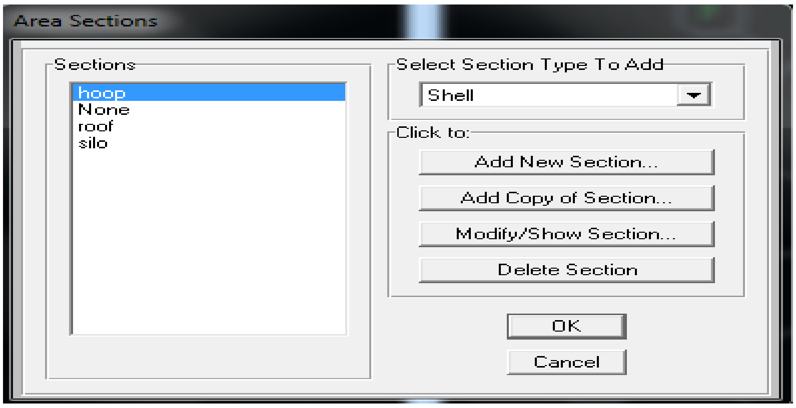


Fig (4.3): Circular silo section definition

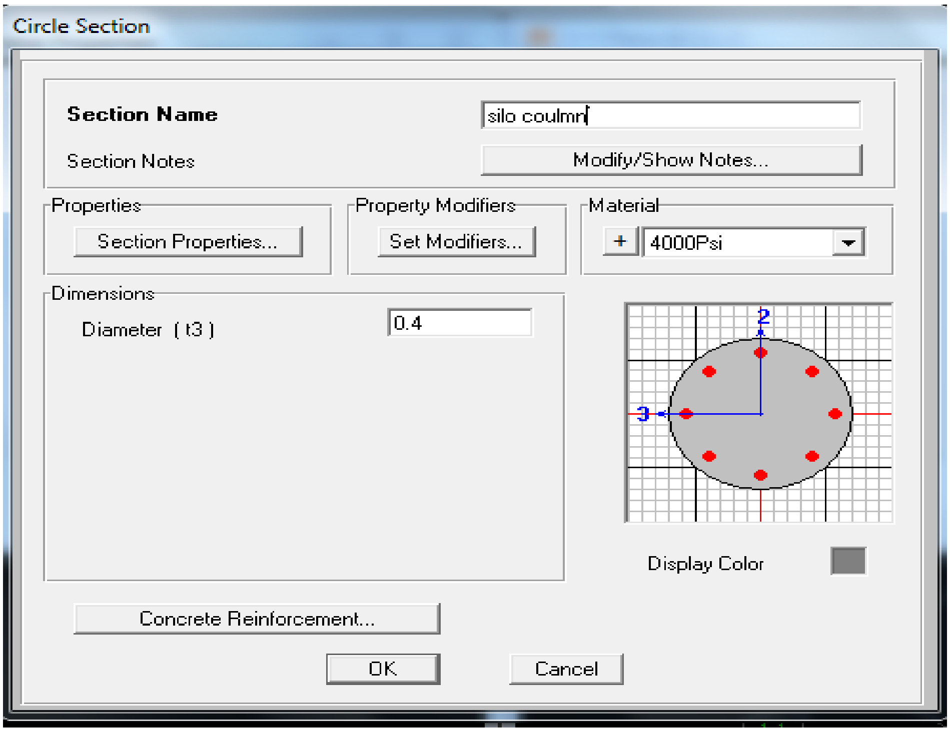


Fig (4.4): Column section of circular silo

4.3.4 Loading:

In this circular silo we there are eight layers every layer under a different amount of pressure as shown in Figures (4.5) to (4.7).

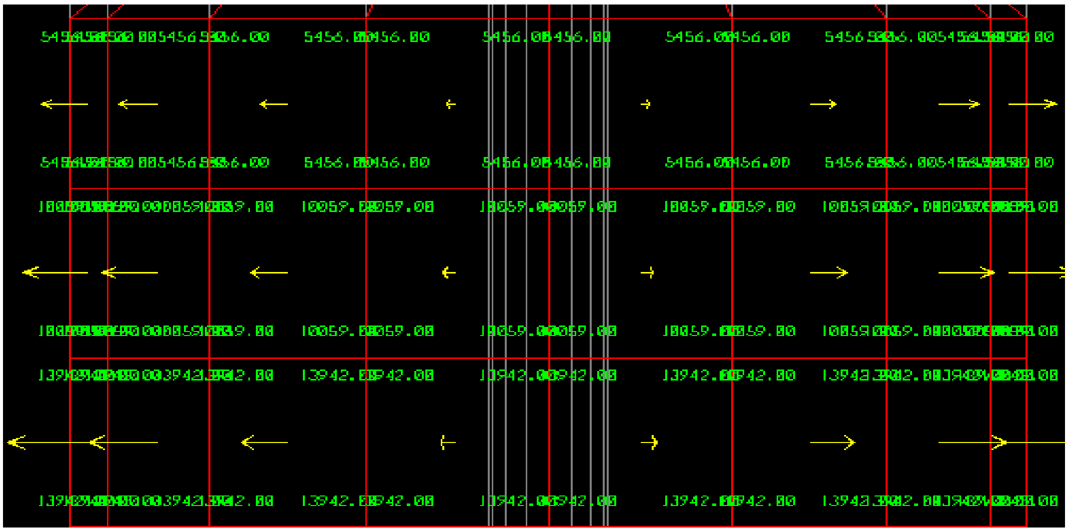


Fig (4.5): Pressure on layers (1, 2, 3) of circular silo

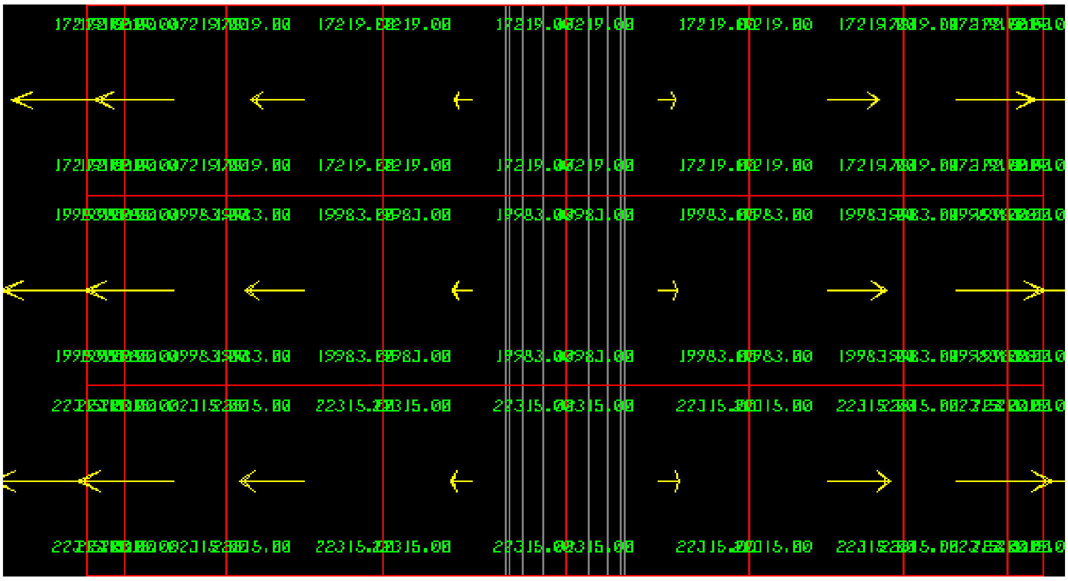


Fig (4.6): Pressure on layers (4, 5, 6) of circular silo

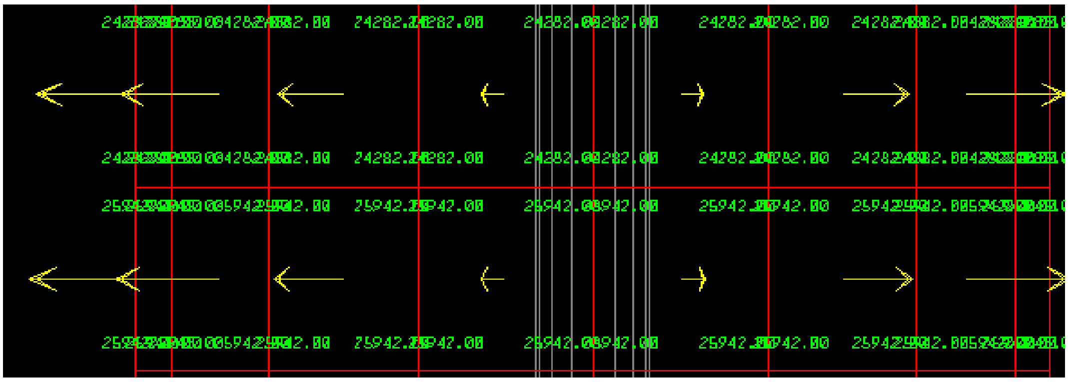


Fig (4.7): Pressure on layers (7, 8) of circular silo

4.4 Analysis results:

After applying loads on every layer then carrying out the analysis of the circular silo model, the results are obtained from SAP2000 and are as shown in Figure (4.8), Table (4.2) and Figure (4.9). The hoop tension was also calculated manually using equation (3.7) the manual calculation results are shown in Table (4.3) and Figure (4.10).

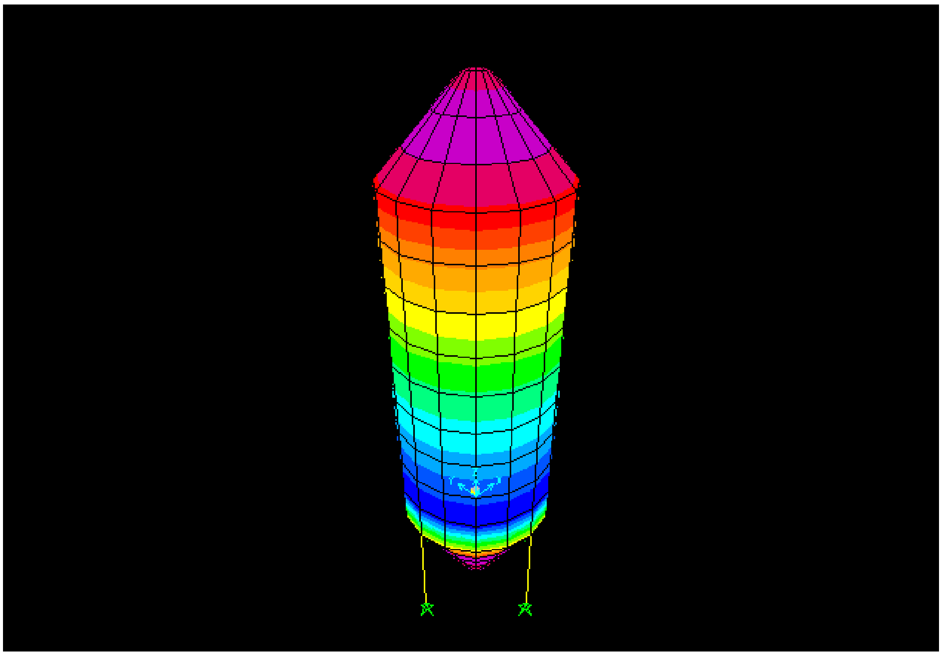


Fig (4.8): Diagram of tension on circular silo

Table (4.2): SAP2000 analysis result of circular silo

Height (m)	Ph (N/m^2)	Hoop tension (N)
1	5456	9950
2	10059	19599
3	13942	27326
4	17219	33719
5	19983	39120
6	22315	43445
7	24282	48340
8	25942	51297

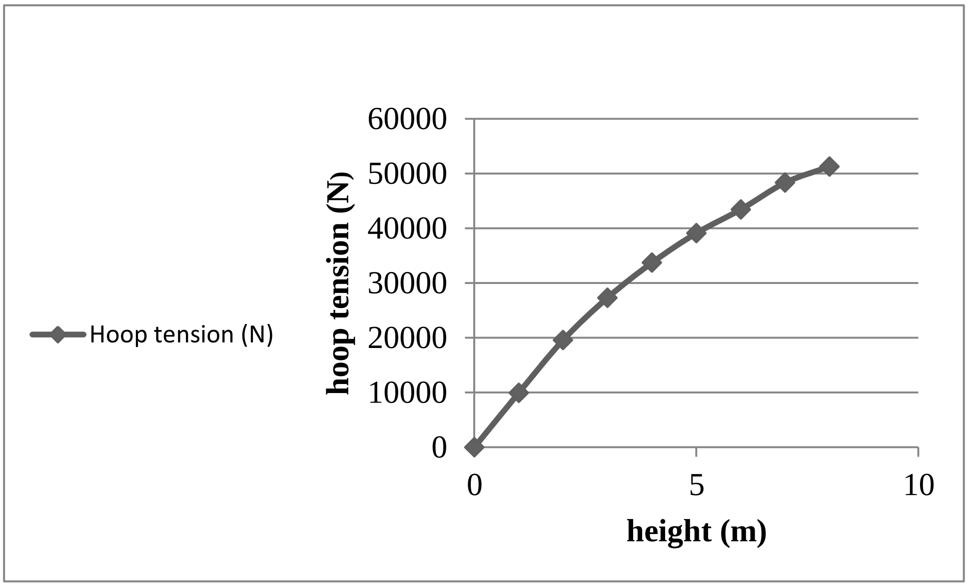


Fig (4.9): Hoop tension for SAP2000 circular silo model

Table (4.3): Manual result of hoop tension of circular silo

Height (m)	Ph (N/m^2)	Hoop tension (N)
1	5456	10912
2	10059	20118
3	13942	27884
4	17219	34438
5	19983	39966
6	22315	44630
7	24282	48546
8	25942	51884

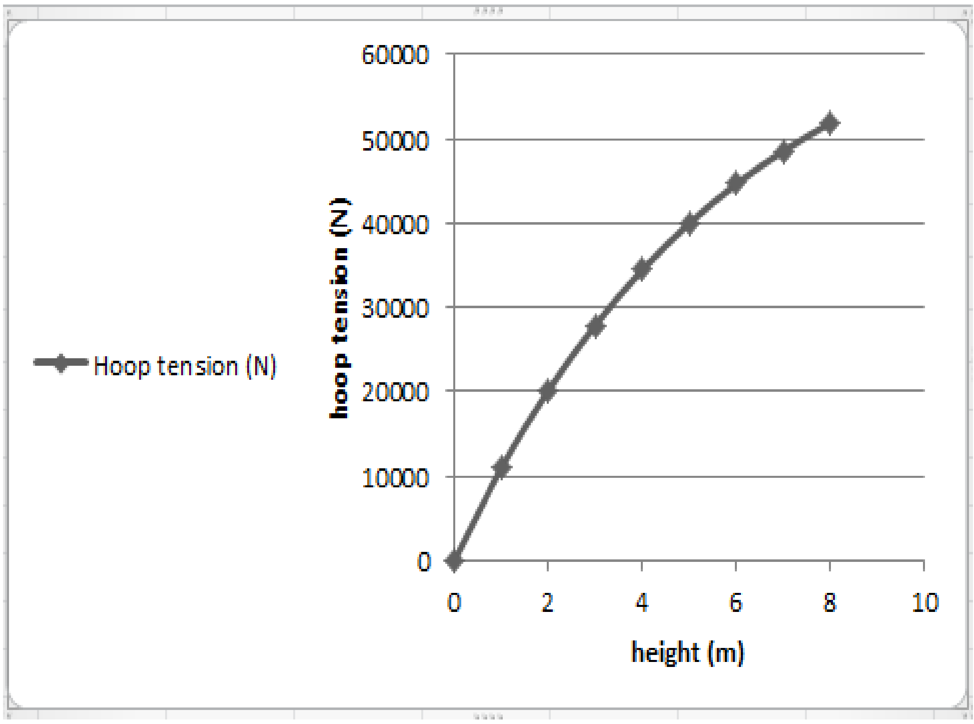


Fig (4.10): Hoop tension manual result of circular silo

The comparison between SAP2000 program and manual hoop tension result was presented in Table (4.4) and Figure (4.11).

Table (4.4): Comparison between manual and SAP hoop tension of circular silo

Height (m)	Hoop tension		
	Manual (N)	SAP2000 (N)	Difference %
1	10912	9950	9
2	20118	19599	2
3	27884	27326	2
4	34438	33719	2
5	39966	39120	2
6	44639	43445	2
7	48564	48346	0.4
8	51884	51297	1

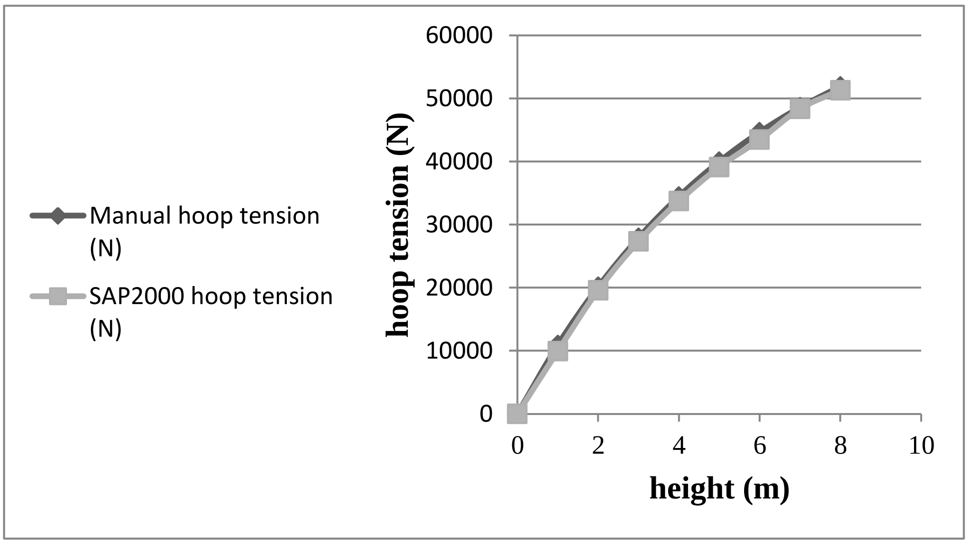


Fig (4.11): Comparison hoop tension manual and SAP for circular silo

4.5 Circular silo design:

From hoop tension results the area of steel and spacing of steel reinforcement on every layer on silo was calculated using equation (3.10). The design results are shown in Table (4.5) and Figure (4.12) for SAP2000 results and in Table (4.6) and Figure (4.13) for manual calculated results.

Table (4.5) Design of circular silo according to SAP results

Height (m)	Area of steel (mm^2)	Diameter of steel (mm)	Spacing c/c mm
1	42.36	10	300
2	83.44	10	300
3	116.33	10	300
4	143.55	10	300
5	166.54	10	300
6	184.95	10	300
7	205.82	10	300
8	218.38	10	300

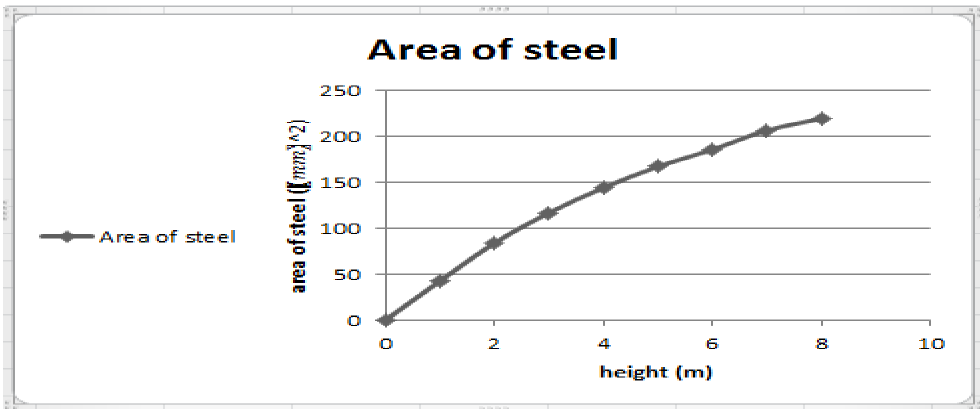


Fig (4.12): Area of steel for SAP2000 of circular silo

Table (4.6): Design of circular silo according to manual results

Height (m)	Area of steel (mm^2)	Diameter of steel (mm)	Spacing c/c (mm)
1	46.45	10	300
2	85.65	10	300
3	118.70	10	300
4	146.60	10	300
5	170.14	10	300
6	190	10	300
7	206.74	10	300
8	220.88	10	300

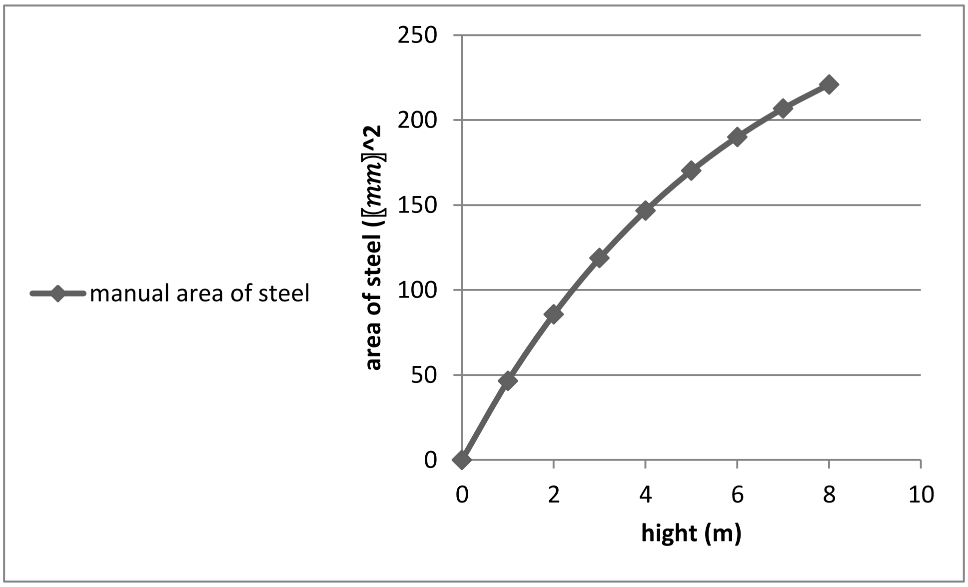


Fig (4.13): Area of steel of manual result of circular silo

The comparison between results of SAP2000 and manual result of area of steel was presented Table (4.7) and Figure (4.14).

Table (4.7): Comparison between area of steel of manual and SAP result of circular silo

Height (m)	Area of steel(mm^2)		
	Manual	SAP2000	Difference%
1	46.45	42.36	9
2	85.65	83.44	2
3	118.70	116.33	2
4	146.60	143.55	2
5	170.14	166.54	2
6	190	184.95	2
7	206.74	205.82	0.4
8	220.88	218.38	1

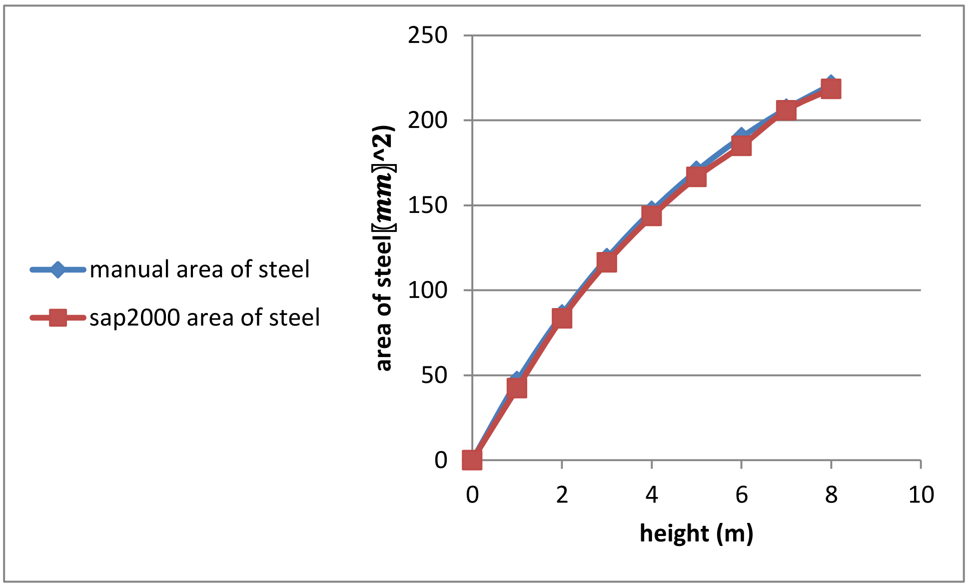


Fig (4.14): Comparison area of steel of manual and SAP for circular silo

4.6 Deformed shape of circular silo:

The deformed shape of circular silo is shown in Figure (4.15)

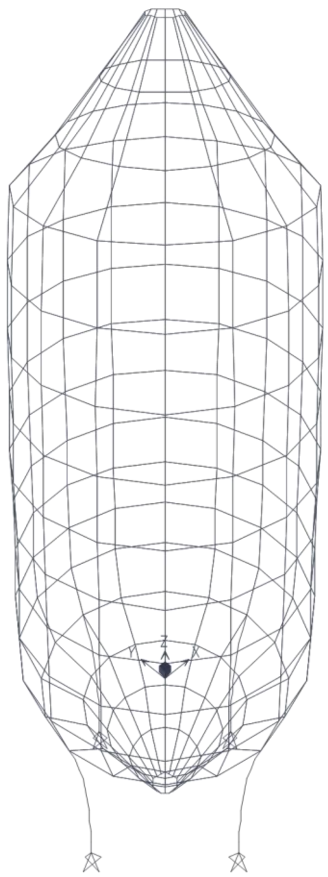


Figure (4.15) Deformed shape of circular silo

4.7 Stresses on circular silo:

The element stresses on silo vary from one layer to another. Table (4.8) shows a sample of stresses. The complete distribution of stresses is presented in (Appendix B).

Table (4.8) Sample of element stresses on circular silo

Area element	Shell type	Joint	Output case	Case type	S11 N/m2	S22 N/m2	S12 N/m2
1	Shell-Thin	4	siloh	LinStatic	5801.25	3882.39	73.77
2	Shell-Thin	6	siloh	LinStatic	5840.59	3961.28	-71.43
3	Shell-Thin	6	siloh	LinStatic	5840.59	3961.28	71.43
4	Shell-Thin	10	siloh	LinStatic	5801.25	3882.39	-73.77
5	Shell-Thin	10	siloh	LinStatic	5801.25	3882.39	73.77
6	Shell-Thin	14	siloh	LinStatic	5840.59	3961.28	-71.43
7	Shell-Thin	14	siloh	LinStatic	5840.59	3961.28	71.43
8	Shell-Thin	18	siloh	LinStatic	5801.25	3882.39	-73.77
9	Shell-Thin	18	siloh	LinStatic	5801.25	3882.39	73.77
10	Shell-Thin	22	siloh	LinStatic	5840.59	3961.28	-71.43
246	Shell-Thin	262	siloh	LinStatic	2196.12	135.53	56.91
247	Shell-Thin	263	siloh	LinStatic	2196.12	135.53	56.91
248	Shell-Thin	264	siloh	LinStatic	2196.12	135.53	56.91
249	Shell-Thin	265	siloh	LinStatic	2196.12	135.53	56.91
250	Shell-Thin	266	siloh	LinStatic	2196.12	135.53	56.91
251	Shell-Thin	267	siloh	LinStatic	2196.12	135.53	56.91
252	Shell-Thin	268	siloh	LinStatic	2196.12	135.53	56.91
253	Shell-Thin	269	siloh	LinStatic	2196.12	135.53	56.91
254	Shell-Thin	270	siloh	LinStatic	2196.12	135.53	56.91
255	Shell-Thin	271	siloh	LinStatic	2196.12	135.53	56.91
256	Shell-Thin	272	siloh	LinStatic	2196.12	135.53	56.91

4.8 Verification of model:

In this chapter verification for SAP2000 program silo model has been carried out by analysis and design circular silo with known published results. The silo also manually analysed and designed.

The results obtained by program are compared with manual results and the maximum difference in hoop tension is 9% and maximum difference in area of steel is 9%. These show very close agreement, thus verifying the accuracy of numerical model. A more comprehensive study is carried out in the next chapter.

CHAPTER FIVE

ANALYSIS AND DESIGN OF SEAN GRAIN SILO

5.1 Introduction:

SAP2000 program was used for analysis and design of Sean reinforced concrete circular grain silo. The silo was also analysed and designed manually and the results were compared with SAP 2000 results.

The silo is a circular concrete silo having a height of 15 m and a diameter of 22.5 m. The stored material is wheat with capacity of 5000 tones. The density of granular material is 8.5 KN/m^2. The angle of internal friction is 28 degree (Appendix A) and the angle of wall friction is 21 degree (Appendix A). The sections of the Sean grain silo are roof section with thickness 0.3m, the main silo section with thickness 0.3 m and column section with diameter 0.55m.

5.2 Pressure calculations:

According to equation (3.2): K =$\frac{1-sin28}{1+sin28}$ =0.361

According to equation (3.4): A = π (506.25)/4 = 397.6 m2

According to equation (3.5): U = π (22.5) = 70.6

According to equation (3.3): R = 397.6/70.6 = 5.63

According to equation (3.6):μ′ =tan21=0.384

Use this relations and equation (3.7) the pressure various depth was calculated and is presented in Table (5.1).

Table (5.1): Pressure calculation of Sean silo with Janssen's theory

Height (m)	**ph (kN/m^2)**
1	3.025
2	5.965
3	8.823
4	11.600
5	14.300
6	16.924
7	19.474
8	21.953
9	24.703
10	26.703
11	28.979
12	31.190
13	33.340
14	35.430
15	37.460

5.3 Modelling of SAP2000:

5.3.1Silo model:

The model start by choosing circular silo with a diameter of 22.5m and 15 layers every layer have a height of 1m , the element use in the model is shell element. The model of circular silo is presented in Figure (5.1).

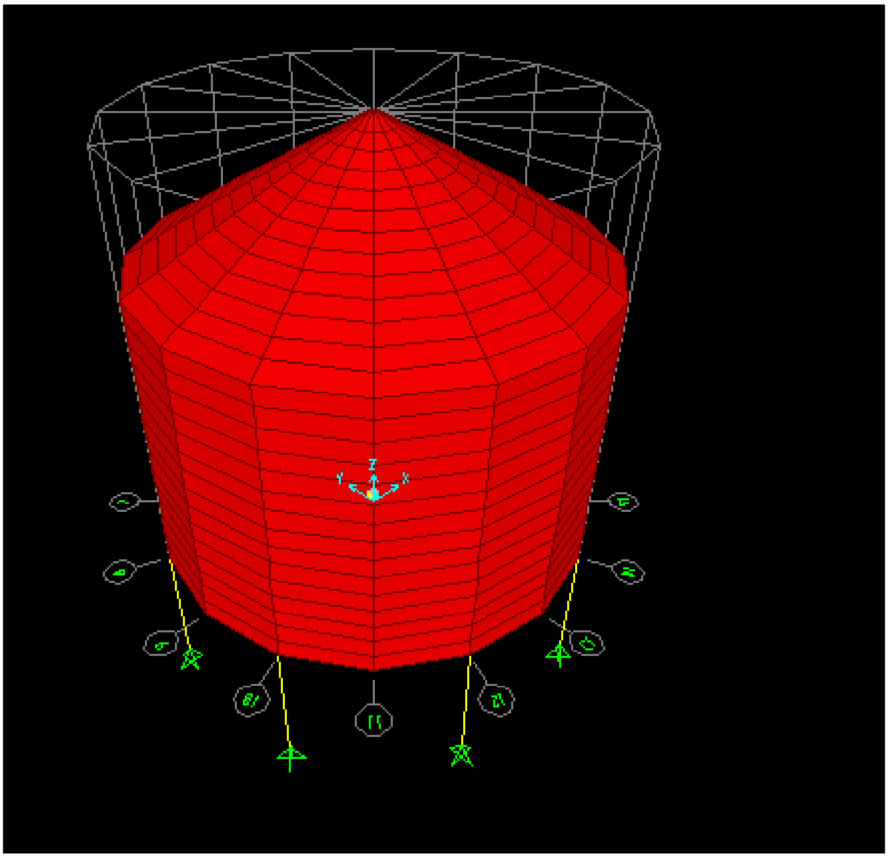


Fig (5.1): Sean grain silo model

5.3.2Material definition:

The material of Sean silo is reinforced concrete on SAP2000 as shown in Figure (5.2).

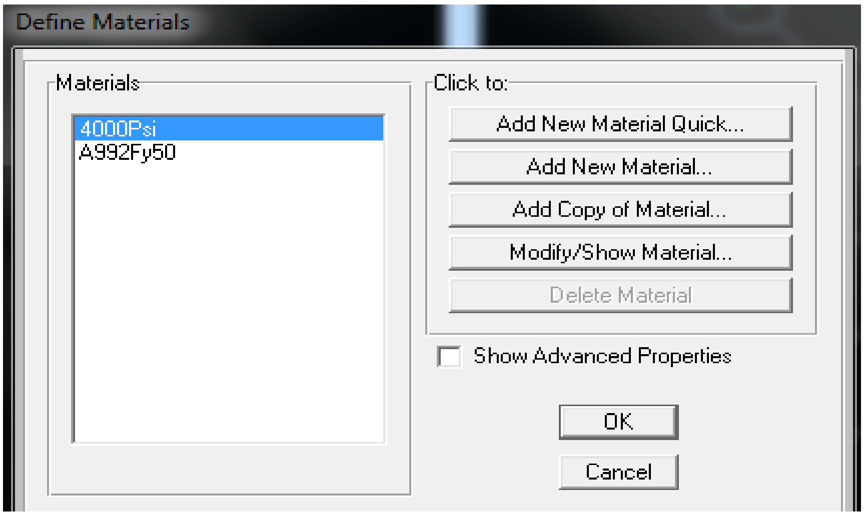


Fig (5.2): Material defines of Sean grain silo

5.3.3 Sections definition:

The silo divided in to two sections which are roof section and main silo section. This section definition was shown in Figure (5.3). And the column section was shown in Figure (5.4).

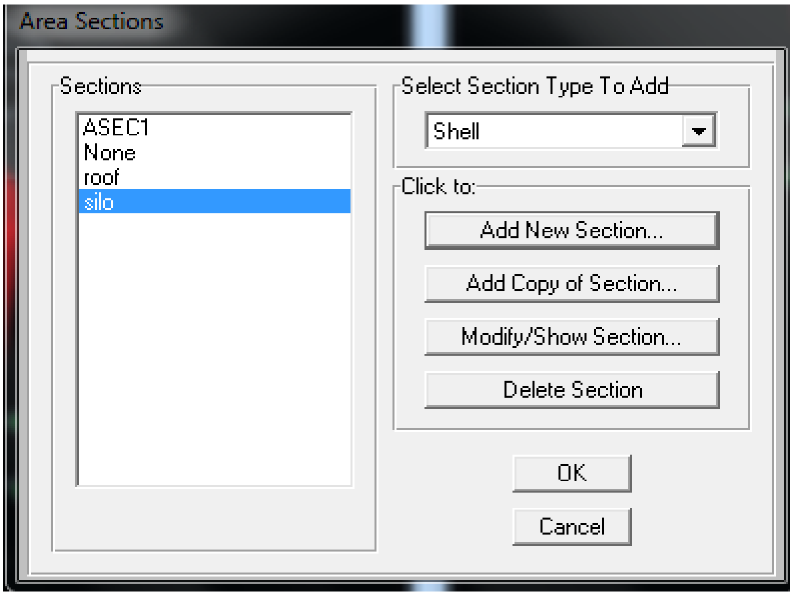


Fig (5.3): Sean grain silo sections definition

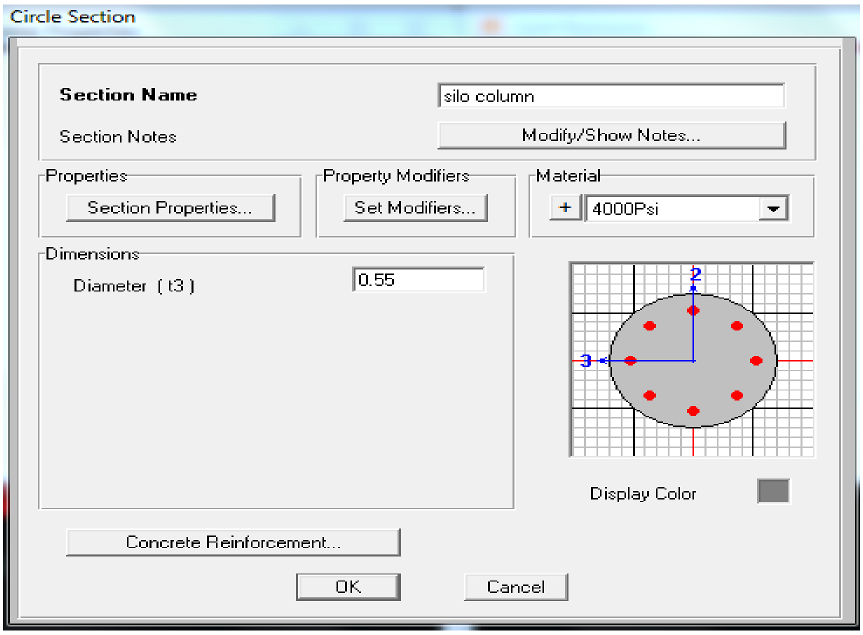


Fig (5.4): Column section of Sean silo

5.3.4 Loading:

In this Sean silo there are fifteen layers every layer under a different amount of pressure as shown in Figures (5.5) to (5.7).

Fig (5.5): Pressure on layers (1, 2, 3, 4, 5, 6) Sean grain silo

Fig (5.6): Pressure on layers (7, 8, 9, 10, 11) Sean grain silo

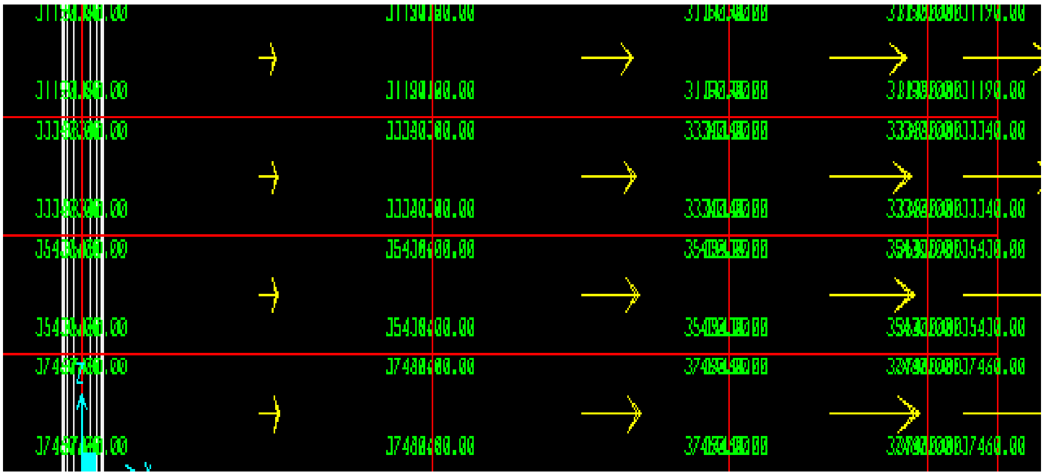


Fig (5.7): Pressure on layers (12, 13, 14, 15) Sean grain silo

5.4 Analysis results:

After applying loads on every layer then carrying out the analysis of Sean silo model, the results obtained from SAP2000 and are shown in Figure (5.8), Table (5.2) and Figure (5.9). The hoop tension was also calculated manually using equation (3.7). The manual calculated results are shown in table (5.3) and Figure (5.10).

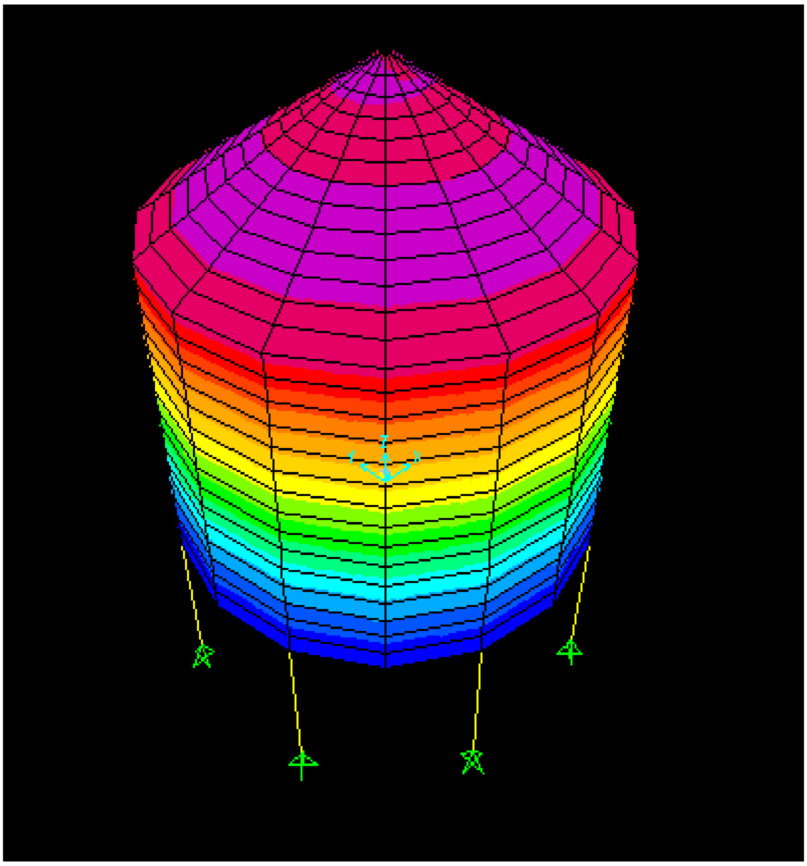


Fig (5.8): Result diagram of Sean grain silo

Table (5.2): SAP2000 analysis results of Sean grain silo

Height (m)	**Ph (N/m^2)**	**Hoop tension (N)**
1	3025	31912.85
2	5965	62563.40
3	8823	95514.78
4	11600	127337.32
5	14300	157711.91
6	16924	186780.99
7	19474	214826.55
8	21953	242040.11
9	24362	268529.54
10	26703	294407.7
11	28979	319742.34
12	31190	344575.99
13	33340	368478.20
14	35430	390345.30
15	37460	416443.26

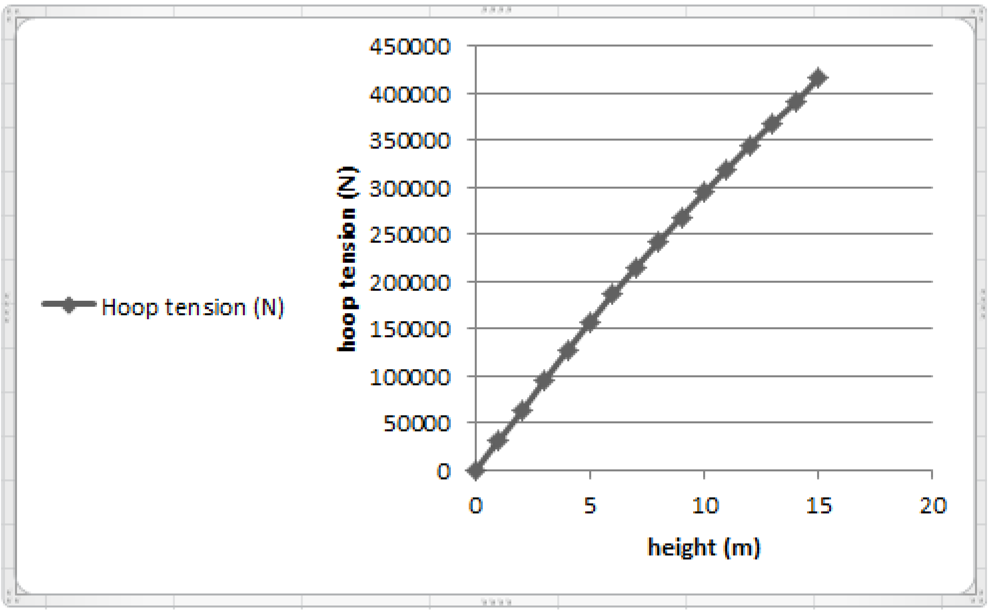


Fig (5.9): Hoop tension of Sean silo model by SAP2000

Table (5.3): Manual result of hoop tension of Sean silo

Height (m)	**Ph (N/m^2)**	**Hoop tension (N)**
1	3025	34031.25
2	5965	67106.25
3	8823	99258.75
4	11600	130500
5	14300	160875
6	16924	190395
7	19474	219082.5
8	21953	246971.25
9	24362	274072.5
10	26703	300408.75
11	28979	326013.75
12	31190	350887.5
13	33340	375075
14	35430	398587.5
15	37460	421425

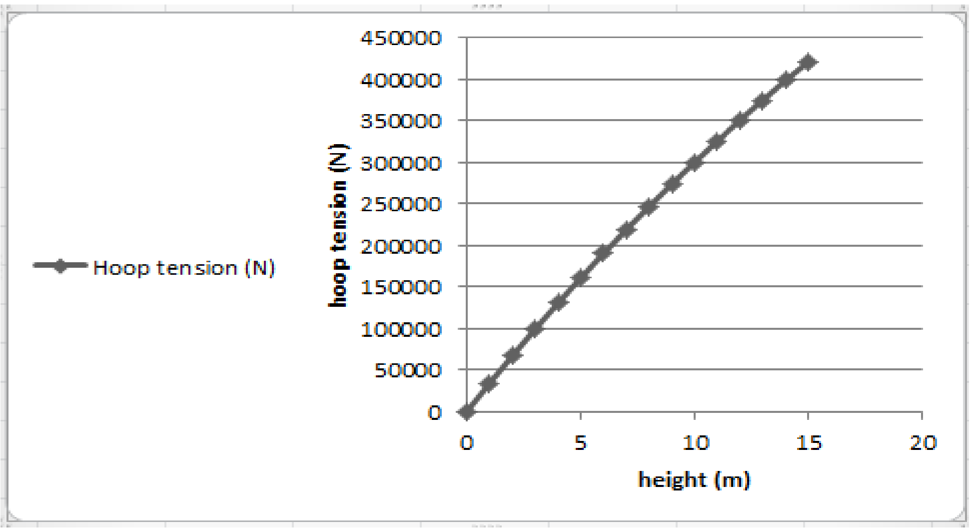


Fig (5.10): Hoop tension manual results of Sean silo

The comparison between SAP2000 program and manual hoop tension result was presented in Table (5.4) and Figure (5.11).

Table (5.4): Comparison between manual and SAP hoop tension of Sean silo

Height (m)	Hoop tension (N)		
	Manual	SAP2000	Difference%
1	34031.25	31912.85	6
2	67106.25	62887.45	6
3	99258.75	95514.78	4
4	130500	127337.32	2
5	160875	157711.91	2
6	190395	186780.99	2
7	219082.5	214826.55	2
8	246971.25	242040.11	2
9	274072.5	268529.54	2
10	300408.75	294407.70	2
11	326013.75	319742.34	2
12	350887.5	344575.99	2
13	375075	368478.20	2
14	398587.5	390345.30	2
15	421425	416443.26	1

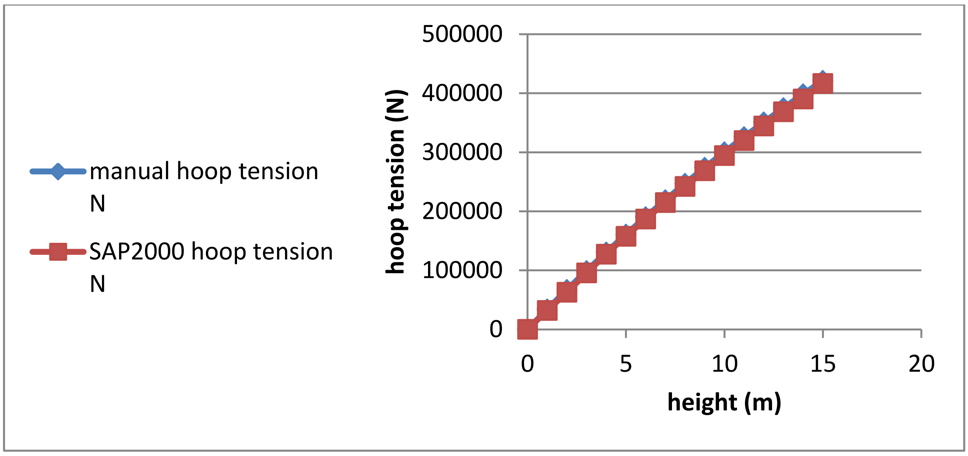


Fig (5.11): comparison hoop tension manual and SAP for Sean silo

5.٥ Sean silo design:

From hoop tension results we can the area of steel and spacing of steel reinforcement on every layer on silo, was calculated using equation (3.10). The design results are shown in Table (5.5) and Figure (5.12) for SAP2000 results and in Table (5.6) and Figure (5.13) for manual calculated results.

Table (5.5): Design of Sean grain silo according to SAP2000 results

Height (m)	Area of steel (mm^2)	Diameter of steel (mm)	Spacing C/C (mm)
1	146.72	10	200
2	289.13	10	200
3	439.15	16	200
4	585.46	16	200
5	725.11	16	200
6	858.76	16	200
7	987.70	16	200
8	1112.82	22	200
9	1234.62	22	200
10	1353.60	22	200
11	1470.08	22	200
12	1584.25	22	200
13	1694.15	22	200
14	1794.69	22	200
15	1914.68	22	200

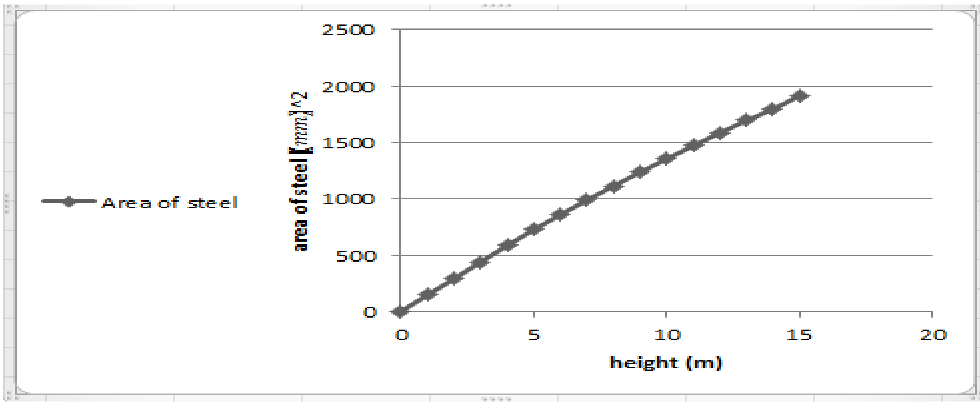


Fig (5.12): area of steel for SAP٢٠٠٠ of Sean grain silo

Table (5.6): design of Sean grain silo according to manual result

Height (m)	Area of steel (mm^2)	Diameter (mm)	Spacing C/C (mm)
1	156.46	10	200
2	308.53	10	200
3	456.36	16	200
4	600	16	200
5	739.66	16	200
6	875.38	16	200
7	1007.28	16	200
8	1135.5	22	200
9	1260.10	22	200
10	1381.18	22	200
11	1498.91	22	200
12	1613.28	22	200
13	1724.48	22	200
14	1832.58	22	200
15	1937.58	22	200

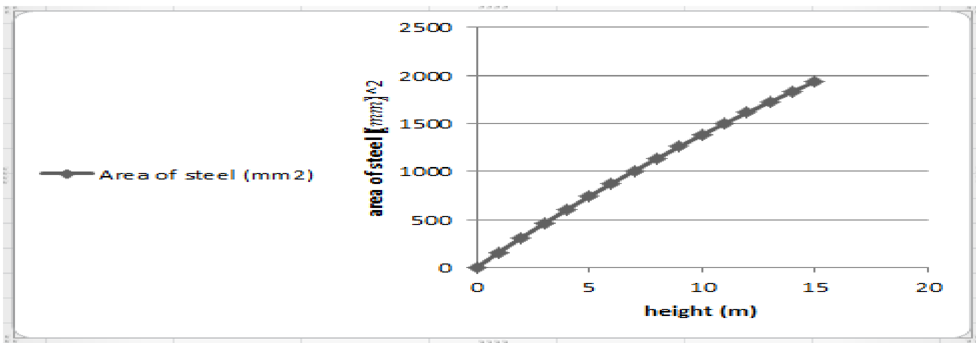


Fig (5.13): area of steel of manual results of Sean grain silo

The comparison between results of SAP2000 and manual result of area of steel was presented Table (5.7) and Figure (5.14).

Table (5.7): Comparison between area of steel of manual and SAP2000 results of Sean grain silo

Height (m)	Area of steel (mm^2)		
	manual	SAP2000	Difference%
1	156.46	146.72	6
2	308.53	289.13	6
3	456.36	439.15	4
4	600	585.46	2
5	739.66	725.11	2
6	875.38	858.76	2
7	1007.28	987.70	2
8	1135.5	1112.82	2
9	1260.10	1234.62	2
10	1381.18	1353.60	2
11	1498.91	1470.08	2
12	1613.28	1584.25	2
13	1724.48	1694.15	2
14	1832.58	1794.69	2
15	1937.58	1914.68	1

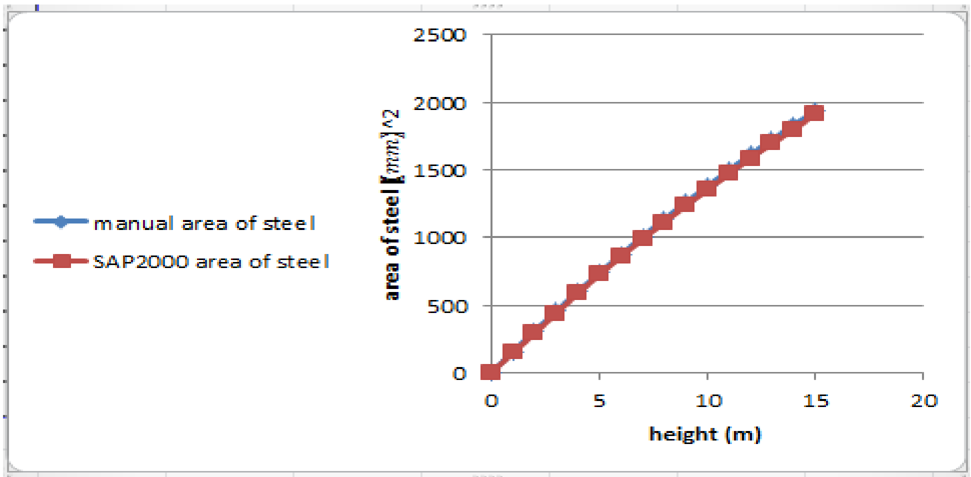


Fig (5.14): comparison area of steel of manual and SAP2000 for Sean grain silo

5.6 Dformed shape of Sean silo:

The deformed shape of Sean silo is shown in Figure (5.15).

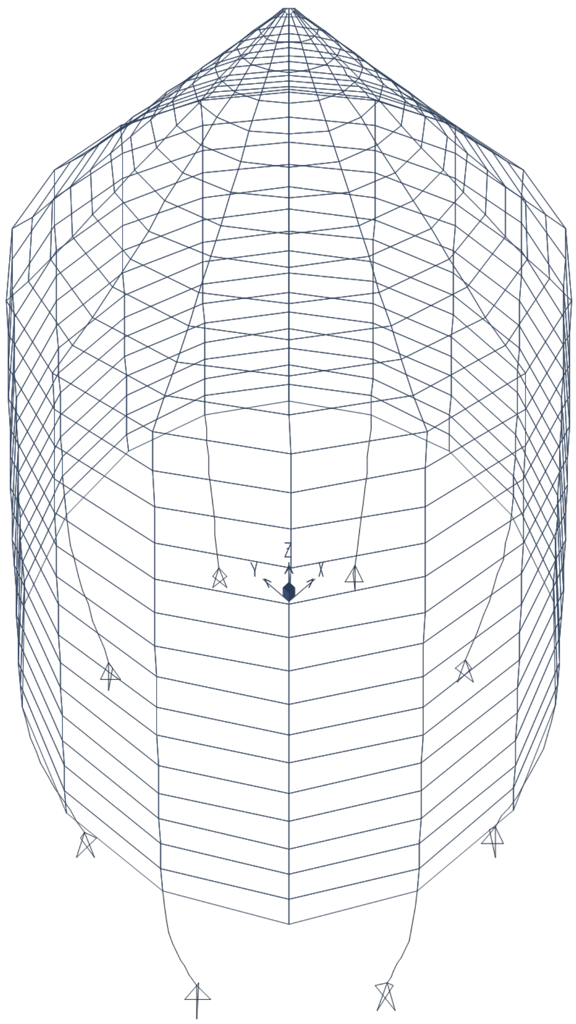


Figure (5.15) Deformed shape of Sean silo

5.7 Stresses on Sean silo:

The element stresses on silo are from one layer to another. Table (5.8) shows a sample of stresses. The complete distribution of stresses is presented in (Appendix c).

Table (5.8) Sample of element stresses on Sean silo

Area element	Shell type	joint	Output case	Case type	S11 N/m2	S22 N/m2	S12 N/m2
1	Shell-Thin	1	Siloh	LinStatic	1405362.87	-45090.33	5849.04
2	Shell-Thin	5	Siloh	LinStatic	1411506.90	-42846.72	-3096.90
3	Shell-Thin	5	Siloh	LinStatic	1404581.64	-44969.77	5983.12
4	Shell-Thin	9	Siloh	LinStatic	1411872.74	-42775.96	-3087.38
5	Shell-Thin	9	Siloh	LinStatic	1404833.47	-44961.50	5996.64
6	Shell-Thin	13	Siloh	LinStatic	1411890.12	-42861.67	-3038.63
7	Shell-Thin	13	Siloh	LinStatic	1404916.67	-45030.15	5924.45
8	Shell-Thin	17	Siloh	LinStatic	1411837.16	-42877.05	-3032.82
9	Shell-Thin	17	Siloh	LinStatic	1404853.17	-45038.05	5928.50
10	Shell-Thin	21	Siloh	LinStatic	1411904.00	-42869.15	-3028.12
438	Shell-Thin	455	Siloh	LinStatic	34.31	45.27	116.31
439	Shell-Thin	456	Siloh	LinStatic	133.23	50.99	97.80
440	Shell-Thin	457	Siloh	LinStatic	194.24	47.35	48.75
441	Shell-Thin	457	Siloh	LinStatic	194.38	47.12	-48.26
442	Shell-Thin	458	Siloh	LinStatic	133.73	51.08	-97.61
443	Shell-Thin	459	Siloh	LinStatic	34.89	45.61	-116.51
444	Shell-Thin	461	Siloh	LinStatic	-43.54	10.76	-74.97
445	Shell-Thin	462	Siloh	LinStatic	-52.24	71.23	51.27
446	Shell-Thin	463	Siloh	LinStatic	16.04	75.47	118.36
447	Shell-Thin	464	Siloh	LinStatic	122.99	46.51	138.36
448	Shell-Thin	464	Siloh	LinStatic	205.03	-18.93	63.20

5.8 Analysis and discussion of results:

1. The hoop tension increases with increasing height. Area of steel also increases with increasing height.
2. SAP2000 program gives more accurate results than the manual methods.
3. Hoop tension and the difference between SAP2000 program and manual method in hoop tension varies between each layer and the other. The maximum value of the difference is 6% in the first and second layers then decreases until it reaches the lowest value which is 1%in the last layer.
4. Area of steel and difference in area of steel according to SAP2000 program result and manual result varies between each layer and the other. The maximum value of the difference is 6% in the first and second layers the decreases until it reaches the lowest value which is 1% in the last layer.
5. The minimum hoop tension obtained from SAP2000 is 31912.85N in the first layer and the maximum hoop tension is 416443.26N in the last layer.
6. The minimum area of steel according to hoop tension of SAP2000 result is 146.72mm2 in the first layer and the maximum area of steel is 1914.68mm2 in the last layer.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1Conclusions:

Conclusions were drawn as follow:

1. A silo of 8m height and 4m diameter was used to check the finite element model and to confirm the possibility of using SAP2000 program.
2. The reinforced concrete Sean grain silo which is of 15m height and 22.5m diameter was analysed using SAP2000 and manually using Janssen's theory.
3. The pressures calculated manually by Janssen's theory were entered on SAP2000 program silo model to get hoop tension.
4. The hoop tension was calculated manually.
5. The design of silos was done manually using the hoop tension value obtained from SAP2000 program and those calculated manually.
6. The difference in the result of hoop tension between manual and SAP2000 program is not more than 6%.
7. The difference between area of steel according to SAP2000 program and area of steel according to manual result is not more than 6%.
8. Reinforcement is found to varying along depth of silo wall.

6.2 Recommendations:

a. The following is recommended for future studies:

1. To analysis and design silos with different materials and compare them with reinforced concrete silos.
2. To develop program to calculate pressure on silo.
3. To develop program to design silo automatically after getting analysis result.
4. To multiply hoop tension by factor of safety.
5. To specify frictions angle of stored material before starting calculating pressure.
6. To take into account the impact of bulk stored material properties on pressure.

b. The following is recommended as result of the study:

1. Using manual calculations for small size silos.
2. Using numerical analysis if the distribution of stresses is required.
3. Using numerical analysis for thin silos to obtain the deformed shape and look into the possibility of local buckling.

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Appendix A

Table A.1bulk density and angle of friction of stored material

IS : 4995 (Part I) - 1974

TABLE 1 BULK DENSITY AND ANGLE OF INTERNAL FRICTION OF STORED MATERIALS

(*Clauses* 1.3, 5.2 *and* 6.2.1)

Sl No.	Material	Bulk Density, W (kg/m³)	Angle of Internal Friction ($\phi°$)
(1)	(2)	(3)	(4)
i)	Food grains and milled products:		
	a) Wheat	850	28
	b) Paddy	575	36
	c) Rice	900	33
	d) Maize	800	30
	e) Barley	690	27
	f) Corn	800	27
	g) Sugar	820	35
	h) Wheat flour	700	30
ii)	Coal:		
	a) Bituminous, dry and broken	800	35
	b) Raw (10 mm size)	1 040	40
	c) Pulverized, aerated	570	20
	d) Pulverized, compacted	890	25
iii)	Anthracite:		
	a) Dry and broken	890	27
	b) Pulverized, aerated	650	20
	c) Pulverized, compacted	970	25
iv)	Coke:		
	Dry, broken and loose	430	30
v)	Ash :		
	a) Dry and compacted	720	40
	b) Loose	650	30
	c) From pulverized fuel, dry and loose	1 120	30
vi)	Ores:		
	a) Haematite (10 mm size)	3 700	35
	b) Magnetite	4 000	35
	c) Manganese	2 570-2 900	35
	d) Limestone	1 300-1 800	35
	e) Copper and zinc	2 570-2 900	35
	f) Lead	5 250	35
vii)	Others:		
	a) Cement	1 550	25
	b) Cement clinker	1 650	35-37
	c) Pulverized lime	1 350	25

NOTE — The values given in Table 1 may not be taken to be applicable universally. The bulk density and angle of internal friction depend upon many variable factors, such as moisture content, particle size and temperature, etc. Wherever possible tests shall be conducted on actual samples to obtain the above values under actual conditions of storage.

Table A.2 angle of wall friction and pressure ratio

IS : 4995 (Part I) - 1974

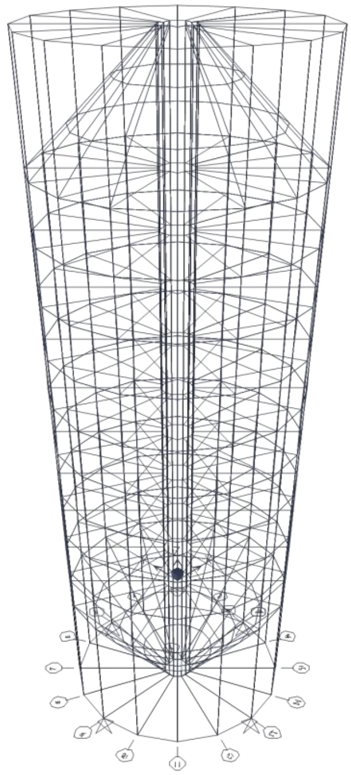
TABLE 2 ANGLE OF WALL FRICTION AND PRESSURE RATIO

(*Clauses* 5.3, 5.3.1, 5.3.2 *and* 6.2.1)

Sl No.	Material	Angle of Wall Friction, δ		Pressure Ratio, λ	
		While Filling	While Emptying	While Filling	While Emptying
(1)	(2)	(3)	(4)	(5)	(6)
i)	Granular materials with mean particle diameter $\geq$ 0·2 mm	0·75 ϕ	0·6 ϕ	0·5	1·0
ii)	Powdery materials (except wheat flour) with mean particle diameter $<$0·06 mm	1·0 ϕ	1·0 ϕ	0·5	0·7
iii)	Wheat flour	0·75 ϕ	0·75 ϕ	0·5	0·7

Appendix B

SAP2000®



SAP2000 Analysis Report

Model Name: circular silo.SDB

B1. Properties:

B1.1 Material properties

This section provides material property information for materials used in the model.

Table B1: Material Properties

Material	UnitWeight	UnitMass	E1	G12	U12	A1
	N/m3	Kg/m3	N/m2	N/m2		1/C
4000Psi	2.3563E+04	2.4028E+03	2.486E+10	1.036E+10	0.200000	9.9000E-06

B1.2 Section properties

This section provides section property information for objects used in the model.

a. Frames

Table cBa frame section properties

SectionName	Material	Shape
silo coulmn	4000Psi	Circle

b.Areas

Table cBb area section properties

Section	Material	MatAngle	AreaType	Type	DrillDOF	Thickness
		Degrees				m
hoop	4000Psi	0.000	Shell	Shell-Thin	Yes	0.250000
roof	4000Psi	0.000	Shell	Shell-Thin	Yes	0.280000
silo	4000Psi	0.000	Shell	Shell-Thin	Yes	0.280000

B2. Load patterns

This section provides loading information as applied to the model.

B2.1. Definitions

Table B2: Load Pattern Definitions

LoadPat	DesignType	SelfWtMult
siloh	HOR EARTH PR	0.000000

B3. Structure results

This section provides structure results, including items such as structural periods and base reactions.

B3.1 element stresses

Table B3: Element Stresses

area	Area element	Shell type	joint	Output case	Case type	S11 N/m2	S22 N/m2	S12 N/m2
1	1	Shell-Thin	4	siloh	LinStatic	5801.25	3882.39	73.77
2	2	Shell-Thin	6	siloh	LinStatic	5840.59	3961.28	-71.43
3	3	Shell-Thin	6	siloh	LinStatic	5840.59	3961.28	71.43
4	4	Shell-Thin	10	siloh	LinStatic	5801.25	3882.39	-73.77
5	5	Shell-Thin	10	siloh	LinStatic	5801.25	3882.39	73.77
6	6	Shell-Thin	14	siloh	LinStatic	5840.59	3961.28	-71.43
7	7	Shell-Thin	14	siloh	LinStatic	5840.59	3961.28	71.43
8	8	Shell-Thin	18	siloh	LinStatic	5801.25	3882.39	-73.77
9	9	Shell-Thin	18	siloh	LinStatic	5801.25	3882.39	73.77
10	10	Shell-Thin	22	siloh	LinStatic	5840.59	3961.28	-71.43
11	11	Shell-Thin	22	siloh	LinStatic	5840.59	3961.28	71.43
12	12	Shell-Thin	26	siloh	LinStatic	5801.25	3882.39	-73.77
13	13	Shell-Thin	26	siloh	LinStatic	5801.25	3882.39	73.77
14	14	Shell-Thin	30	siloh	LinStatic	5840.59	3961.28	-71.43
15	15	Shell-Thin	30	siloh	LinStatic	5840.59	3961.28	71.43
16	16	Shell-Thin	4	siloh	LinStatic	5801.25	3882.39	-73.77
17	17	Shell-Thin	4	siloh	LinStatic	4744.44	3841.38	-419.52
18	18	Shell-Thin	6	siloh	LinStatic	4685.41	4096.40	473.57
19	19	Shell-Thin	6	siloh	LinStatic	4685.41	4096.40	-473.57
20	20	Shell-Thin	10	siloh	LinStatic	4744.44	3841.38	419.52
21	21	Shell-Thin	10	siloh	LinStatic	4744.44	3841.38	-419.52
22	22	Shell-Thin	14	siloh	LinStatic	4685.41	4096.40	473.57
23	23	Shell-Thin	14	siloh	LinStatic	4685.41	4096.40	-473.57
24	24	Shell-Thin	18	siloh	LinStatic	4744.44	3841.38	419.52
25	25	Shell-Thin	18	siloh	LinStatic	4744.44	3841.38	-419.52
26	26	Shell-Thin	22	siloh	LinStatic	4685.41	4096.40	473.57
27	27	Shell-Thin	22	siloh	LinStatic	4685.41	4096.40	-473.57

28	28	Shell-Thin	26	siloh	LinStatic	4744.44	3841.38	419.52
29	29	Shell-Thin	26	siloh	LinStatic	4744.44	3841.38	-419.52
30	30	Shell-Thin	30	siloh	LinStatic	4685.41	4096.40	473.57
31	31	Shell-Thin	30	siloh	LinStatic	4685.41	4096.40	-473.57
32	32	Shell-Thin	4	siloh	LinStatic	4744.44	3841.38	419.52
33	33	Shell-Thin	34	siloh	LinStatic	-6154.57	5023.18	2586.91
34	34	Shell-Thin	33	siloh	LinStatic	-6227.51	4227.69	2663.76
35	35	Shell-Thin	36	siloh	LinStatic	-6227.51	4227.69	-2663.76
36	36	Shell-Thin	37	siloh	LinStatic	-6154.57	5023.18	-2586.91
37	37	Shell-Thin	37	siloh	LinStatic	-6154.57	5023.18	2586.91
38	38	Shell-Thin	38	siloh	LinStatic	-6227.51	4227.69	2663.76
39	39	Shell-Thin	40	siloh	LinStatic	-6227.51	4227.69	-2663.76
40	40	Shell-Thin	40	siloh	LinStatic	-6344.47	4208.13	3092.04
41	41	Shell-Thin	41	siloh	LinStatic	-6154.57	5023.18	2586.91
42	42	Shell-Thin	42	siloh	LinStatic	-6227.51	4227.69	2663.76
43	43	Shell-Thin	44	siloh	LinStatic	-6227.51	4227.69	-2663.76
44	44	Shell-Thin	45	siloh	LinStatic	-6154.57	5023.18	-2586.91
45	45	Shell-Thin	45	siloh	LinStatic	-6154.57	5023.18	2586.91
46	46	Shell-Thin	46	siloh	LinStatic	-6227.51	4227.69	2663.76
47	47	Shell-Thin	48	siloh	LinStatic	-6227.51	4227.69	-2663.76
48	48	Shell-Thin	34	siloh	LinStatic	-6154.57	5023.18	-2586.91
49	49	Shell-Thin	66	siloh	LinStatic	98297.27	47406.94	-3029.28
50	50	Shell-Thin	67	siloh	LinStatic	92652.12	29455.82	-345.71
51	51	Shell-Thin	67	siloh	LinStatic	92652.12	29455.82	345.71
52	52	Shell-Thin	69	siloh	LinStatic	98297.27	47406.94	3029.28
53	53	Shell-Thin	69	siloh	LinStatic	98297.27	47406.94	-3029.28
54	54	Shell-Thin	71	siloh	LinStatic	92652.12	29455.82	-345.71
55	55	Shell-Thin	71	siloh	LinStatic	92652.12	29455.82	345.71
56	56	Shell-Thin	73	siloh	LinStatic	98297.27	47406.94	3029.28
57	57	Shell-Thin	73	siloh	LinStatic	98297.27	47406.94	-3029.28
58	58	Shell-Thin	75	siloh	LinStatic	92652.12	29455.82	-345.71
59	59	Shell-Thin	75	siloh	LinStatic	92652.12	29455.82	345.71
60	60	Shell-Thin	77	siloh	LinStatic	98297.27	47406.94	3029.28
61	61	Shell-Thin	77	siloh	LinStatic	98297.27	47406.94	-3029.28

62	62	Shell-Thin	79	siloh	LinStatic	92652.12	29455.82	-345.71
63	63	Shell-Thin	79	siloh	LinStatic	92652.12	29455.82	345.71
64	64	Shell-Thin	66	siloh	LinStatic	98297.27	47406.94	3029.28
65	65	Shell-Thin	81	siloh	LinStatic	203112.78	55502.21	3276.10
66	66	Shell-Thin	83	siloh	LinStatic	203515.38	57851.18	1765.07
67	67	Shell-Thin	83	siloh	LinStatic	203515.38	57851.18	-1765.07
68	68	Shell-Thin	84	siloh	LinStatic	203112.78	55502.21	-3276.10
69	69	Shell-Thin	86	siloh	LinStatic	203112.78	55502.21	3276.10
70	70	Shell-Thin	87	siloh	LinStatic	203515.38	57851.18	1765.07
71	71	Shell-Thin	87	siloh	LinStatic	203515.38	57851.18	-1765.07
72	72	Shell-Thin	88	siloh	LinStatic	203112.78	55502.21	-3276.10
73	73	Shell-Thin	90	siloh	LinStatic	203112.78	55502.21	3276.10
74	74	Shell-Thin	91	siloh	LinStatic	203515.38	57851.18	1765.07
75	75	Shell-Thin	91	siloh	LinStatic	203515.38	57851.18	-1765.07
76	76	Shell-Thin	92	siloh	LinStatic	203112.78	55502.21	-3276.10
77	77	Shell-Thin	94	siloh	LinStatic	203112.78	55502.21	3276.10
78	78	Shell-Thin	95	siloh	LinStatic	203515.38	57851.18	1765.07
79	79	Shell-Thin	95	siloh	LinStatic	203515.38	57851.18	-1765.07
80	80	Shell-Thin	96	siloh	LinStatic	203112.78	55502.21	-3276.10
81	81	Shell-Thin	81	siloh	LinStatic	200958.38	44730.21	-1880.00
82	82	Shell-Thin	83	siloh	LinStatic	201057.44	45561.49	-2169.22
83	83	Shell-Thin	83	siloh	LinStatic	201057.44	45561.49	2169.22
84	84	Shell-Thin	84	siloh	LinStatic	200958.38	44730.21	1880.00
85	85	Shell-Thin	86	siloh	LinStatic	200958.38	44730.21	-1880.00
86	86	Shell-Thin	87	siloh	LinStatic	201057.44	45561.49	-2169.22
87	87	Shell-Thin	87	siloh	LinStatic	201057.44	45561.49	2169.22
88	88	Shell-Thin	88	siloh	LinStatic	200958.38	44730.21	1880.00
89	89	Shell-Thin	89	siloh	LinStatic	198777.25	46841.06	2938.23
90	90	Shell-Thin	91	siloh	LinStatic	201057.44	45561.49	-2169.22
91	91	Shell-Thin	91	siloh	LinStatic	201057.44	45561.49	2169.22
92	92	Shell-Thin	92	siloh	LinStatic	200958.38	44730.21	1880.00
93	93	Shell-Thin	94	siloh	LinStatic	200958.38	44730.21	-1880.00
94	94	Shell-Thin	95	siloh	LinStatic	201057.44	45561.49	-2169.22
95	95	Shell-Thin	95	siloh	LinStatic	201057.44	45561.49	2169.22

96	96	Shell-Thin	96	siloh	LinStatic	200958.38	44730.21	1880.00
97	97	Shell-Thin	98	siloh	LinStatic	182395.23	-3111.27	-197.12
98	98	Shell-Thin	99	siloh	LinStatic	182552.06	-3057.05	84.85
99	99	Shell-Thin	99	siloh	LinStatic	182552.06	-3057.05	-84.85
100	100	Shell-Thin	101	siloh	LinStatic	182395.23	-3111.27	197.12
101	101	Shell-Thin	101	siloh	LinStatic	182395.23	-3111.27	-197.12
102	102	Shell-Thin	103	siloh	LinStatic	182552.06	-3057.05	84.85
103	103	Shell-Thin	103	siloh	LinStatic	182552.06	-3057.05	-84.85
104	104	Shell-Thin	105	siloh	LinStatic	182395.23	-3111.27	197.12
105	105	Shell-Thin	105	siloh	LinStatic	182395.23	-3111.27	-197.12
106	106	Shell-Thin	107	siloh	LinStatic	182552.06	-3057.05	84.85
107	107	Shell-Thin	107	siloh	LinStatic	182552.06	-3057.05	-84.85
108	108	Shell-Thin	109	siloh	LinStatic	182395.23	-3111.27	197.12
109	109	Shell-Thin	109	siloh	LinStatic	182395.23	-3111.27	-197.12
110	110	Shell-Thin	111	siloh	LinStatic	182552.06	-3057.05	84.85
111	111	Shell-Thin	111	siloh	LinStatic	182552.06	-3057.05	-84.85
112	112	Shell-Thin	98	siloh	LinStatic	182395.23	-3111.27	197.12
113	113	Shell-Thin	113	siloh	LinStatic	161978.14	-255.14	189.50
114	114	Shell-Thin	115	siloh	LinStatic	162061.05	-335.20	182.92
115	115	Shell-Thin	115	siloh	LinStatic	162061.05	-335.20	-182.92
116	116	Shell-Thin	116	siloh	LinStatic	161978.14	-255.14	-189.50
117	117	Shell-Thin	118	siloh	LinStatic	161978.14	-255.14	189.50
118	118	Shell-Thin	119	siloh	LinStatic	162061.05	-335.20	182.92
119	119	Shell-Thin	119	siloh	LinStatic	162061.05	-335.20	-182.92
120	120	Shell-Thin	120	siloh	LinStatic	161978.14	-255.14	-189.50
121	121	Shell-Thin	122	siloh	LinStatic	161978.14	-255.14	189.50
122	122	Shell-Thin	123	siloh	LinStatic	162061.05	-335.20	182.92
123	123	Shell-Thin	123	siloh	LinStatic	162061.05	-335.20	-182.92
124	124	Shell-Thin	124	siloh	LinStatic	161978.14	-255.14	-189.50
125	125	Shell-Thin	126	siloh	LinStatic	161978.14	-255.14	189.50
126	126	Shell-Thin	127	siloh	LinStatic	162061.05	-335.20	182.92
127	127	Shell-Thin	127	siloh	LinStatic	162061.05	-335.20	-182.92
128	128	Shell-Thin	128	siloh	LinStatic	161978.14	-255.14	-189.50
129	129	Shell-Thin	130	siloh	LinStatic	149142.96	4016.73	77.29

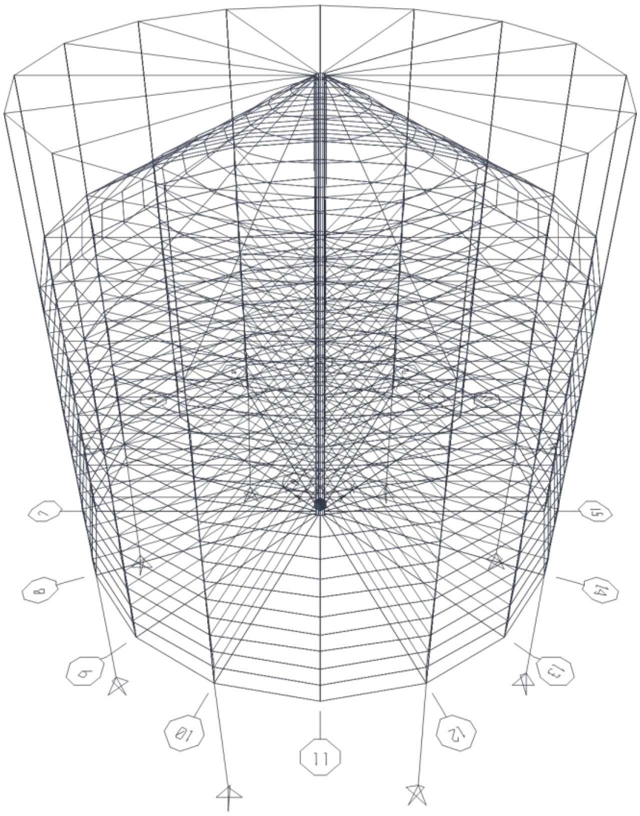
130	130	Shell-Thin	129	siloh	LinStatic	149137.99	3990.56	77.26
131	131	Shell-Thin	132	siloh	LinStatic	149137.99	3990.56	-77.26
132	132	Shell-Thin	132	siloh	LinStatic	149132.60	3991.24	67.30
133	133	Shell-Thin	134	siloh	LinStatic	149132.60	3991.24	-67.30
134	134	Shell-Thin	134	siloh	LinStatic	149137.99	3990.56	77.26
135	135	Shell-Thin	136	siloh	LinStatic	149137.99	3990.56	-77.26
136	136	Shell-Thin	136	siloh	LinStatic	149132.60	3991.24	67.30
137	137	Shell-Thin	138	siloh	LinStatic	149132.60	3991.24	-67.30
138	138	Shell-Thin	138	siloh	LinStatic	149137.99	3990.56	77.26
139	139	Shell-Thin	140	siloh	LinStatic	149137.99	3990.56	-77.26
140	140	Shell-Thin	140	siloh	LinStatic	149132.60	3991.24	67.30
141	141	Shell-Thin	142	siloh	LinStatic	149132.60	3991.24	-67.30
142	142	Shell-Thin	142	siloh	LinStatic	149137.99	3990.56	77.26
143	143	Shell-Thin	144	siloh	LinStatic	149137.99	3990.56	-77.26
144	144	Shell-Thin	130	siloh	LinStatic	149142.96	4016.73	-77.29
145	145	Shell-Thin	146	siloh	LinStatic	131748.55	3689.03	56.84
146	146	Shell-Thin	145	siloh	LinStatic	131745.17	3686.94	57.09
147	147	Shell-Thin	148	siloh	LinStatic	131745.17	3686.94	-57.09
148	148	Shell-Thin	149	siloh	LinStatic	131748.55	3689.03	-56.84
149	149	Shell-Thin	149	siloh	LinStatic	131748.55	3689.03	56.84
150	150	Shell-Thin	150	siloh	LinStatic	131745.17	3686.94	57.09
151	151	Shell-Thin	152	siloh	LinStatic	131745.17	3686.94	-57.09
152	152	Shell-Thin	153	siloh	LinStatic	131748.55	3689.03	-56.84
153	153	Shell-Thin	153	siloh	LinStatic	131748.55	3689.03	56.84
154	154	Shell-Thin	154	siloh	LinStatic	131745.17	3686.94	57.09
155	155	Shell-Thin	156	siloh	LinStatic	131745.17	3686.94	-57.09
156	156	Shell-Thin	157	siloh	LinStatic	131748.55	3689.03	-56.84
157	157	Shell-Thin	157	siloh	LinStatic	131748.55	3689.03	56.84
158	158	Shell-Thin	158	siloh	LinStatic	131745.17	3686.94	57.09
159	159	Shell-Thin	160	siloh	LinStatic	131745.17	3686.94	-57.09
160	160	Shell-Thin	146	siloh	LinStatic	131748.55	3689.03	-56.84
161	161	Shell-Thin	162	siloh	LinStatic	110537.82	3842.54	19.85
162	162	Shell-Thin	161	siloh	LinStatic	110536.01	3842.59	19.50
163	163	Shell-Thin	164	siloh	LinStatic	110536.01	3842.59	-19.50

164	164	Shell-Thin	165	siloh	LinStatic	110537.82	3842.54	-19.85
165	165	Shell-Thin	165	siloh	LinStatic	110537.82	3842.54	19.85
166	166	Shell-Thin	166	siloh	LinStatic	110536.01	3842.59	19.50
167	167	Shell-Thin	168	siloh	LinStatic	110536.01	3842.59	-19.50
168	168	Shell-Thin	169	siloh	LinStatic	110537.82	3842.54	-19.85
169	169	Shell-Thin	169	siloh	LinStatic	110537.82	3842.54	19.85
170	170	Shell-Thin	170	siloh	LinStatic	110536.01	3842.59	19.50
171	171	Shell-Thin	172	siloh	LinStatic	110536.01	3842.59	-19.50
172	172	Shell-Thin	173	siloh	LinStatic	110537.82	3842.54	-19.85
173	173	Shell-Thin	173	siloh	LinStatic	110537.82	3842.54	19.85
174	174	Shell-Thin	174	siloh	LinStatic	110536.01	3842.59	19.50
175	175	Shell-Thin	176	siloh	LinStatic	110536.01	3842.59	-19.50
176	176	Shell-Thin	162	siloh	LinStatic	110537.82	3842.54	-19.85
177	177	Shell-Thin	178	siloh	LinStatic	86393.21	5367.52	-66.11
178	178	Shell-Thin	177	siloh	LinStatic	86392.59	5367.95	-66.21
179	179	Shell-Thin	180	siloh	LinStatic	86392.59	5367.95	66.21
180	180	Shell-Thin	181	siloh	LinStatic	86393.21	5367.52	66.11
181	181	Shell-Thin	181	siloh	LinStatic	86393.21	5367.52	-66.11
182	182	Shell-Thin	182	siloh	LinStatic	86392.59	5367.95	-66.21
183	183	Shell-Thin	184	siloh	LinStatic	86392.59	5367.95	66.21
184	184	Shell-Thin	185	siloh	LinStatic	86393.21	5367.52	66.11
185	185	Shell-Thin	185	siloh	LinStatic	86393.21	5367.52	-66.11
186	186	Shell-Thin	186	siloh	LinStatic	86392.59	5367.95	-66.21
187	187	Shell-Thin	188	siloh	LinStatic	86392.59	5367.95	66.21
188	188	Shell-Thin	189	siloh	LinStatic	86393.21	5367.52	66.11
189	189	Shell-Thin	189	siloh	LinStatic	86393.21	5367.52	-66.11
190	190	Shell-Thin	190	siloh	LinStatic	86392.59	5367.95	-66.21
191	191	Shell-Thin	192	siloh	LinStatic	86392.59	5367.95	66.21
192	192	Shell-Thin	178	siloh	LinStatic	86393.21	5367.52	66.11
193	193	Shell-Thin	194	siloh	LinStatic	56305.06	8965.70	511.92
194	194	Shell-Thin	193	siloh	LinStatic	56305.00	8965.87	511.90
195	195	Shell-Thin	196	siloh	LinStatic	56305.00	8965.87	-511.90
196	196	Shell-Thin	197	siloh	LinStatic	56305.06	8965.70	-511.92
197	197	Shell-Thin	197	siloh	LinStatic	56305.06	8965.70	511.92

198	198	Shell-Thin	198	siloh	LinStatic	56305.00	8965.87	511.90
199	199	Shell-Thin	200	siloh	LinStatic	56305.00	8965.87	-511.90
200	200	Shell-Thin	201	siloh	LinStatic	56305.06	8965.70	-511.92
201	201	Shell-Thin	201	siloh	LinStatic	56305.06	8965.70	511.92
202	202	Shell-Thin	202	siloh	LinStatic	56305.00	8965.87	511.90
203	203	Shell-Thin	204	siloh	LinStatic	56305.00	8965.87	-511.90
204	204	Shell-Thin	205	siloh	LinStatic	56305.06	8965.70	-511.92
205	205	Shell-Thin	205	siloh	LinStatic	56305.06	8965.70	511.92
206	206	Shell-Thin	206	siloh	LinStatic	56305.00	8965.87	511.90
207	207	Shell-Thin	208	siloh	LinStatic	56305.00	8965.87	-511.90
208	208	Shell-Thin	194	siloh	LinStatic	56305.06	8965.70	-511.92
209	209	Shell-Thin	210	siloh	LinStatic	13070.11	-2659.74	-771.42
210	210	Shell-Thin	209	siloh	LinStatic	13070.08	-2659.73	-771.43
211	211	Shell-Thin	212	siloh	LinStatic	13070.08	-2659.73	771.43
212	212	Shell-Thin	212	siloh	LinStatic	13070.08	-2659.74	-771.39
213	213	Shell-Thin	213	siloh	LinStatic	13070.11	-2659.74	-771.42
214	214	Shell-Thin	214	siloh	LinStatic	13070.08	-2659.73	-771.43
215	215	Shell-Thin	216	siloh	LinStatic	13070.08	-2659.73	771.43
216	216	Shell-Thin	217	siloh	LinStatic	13070.11	-2659.74	771.42
217	217	Shell-Thin	217	siloh	LinStatic	13070.11	-2659.74	-771.42
218	218	Shell-Thin	218	siloh	LinStatic	13070.08	-2659.73	-771.43
219	219	Shell-Thin	220	siloh	LinStatic	13070.08	-2659.73	771.43
220	220	Shell-Thin	221	siloh	LinStatic	13070.11	-2659.74	771.42
221	221	Shell-Thin	221	siloh	LinStatic	13070.11	-2659.74	-771.42
222	222	Shell-Thin	222	siloh	LinStatic	13070.08	-2659.73	-771.43
223	223	Shell-Thin	224	siloh	LinStatic	13070.08	-2659.73	771.43
224	224	Shell-Thin	210	siloh	LinStatic	13070.11	-2659.74	771.42
225	225	Shell-Thin	241	siloh	LinStatic	-771.90	1076.54	465.32
226	226	Shell-Thin	241	siloh	LinStatic	-771.89	1076.54	-465.32
227	227	Shell-Thin	244	siloh	LinStatic	-771.89	1076.54	465.32
228	228	Shell-Thin	245	siloh	LinStatic	-771.90	1076.54	465.32
229	229	Shell-Thin	246	siloh	LinStatic	-771.90	1076.54	465.32
230	230	Shell-Thin	247	siloh	LinStatic	-771.89	1076.54	465.32
231	231	Shell-Thin	248	siloh	LinStatic	-771.89	1076.54	465.32

232	232	Shell-Thin	249	siloh	LinStatic	-771.90	1076.54	465.32
233	233	Shell-Thin	250	siloh	LinStatic	-771.90	1076.54	465.32
234	234	Shell-Thin	251	siloh	LinStatic	-771.89	1076.54	465.32
235	235	Shell-Thin	252	siloh	LinStatic	-771.89	1076.54	465.32
236	236	Shell-Thin	253	siloh	LinStatic	-771.90	1076.54	465.32
237	237	Shell-Thin	254	siloh	LinStatic	-771.90	1076.54	465.32
238	238	Shell-Thin	255	siloh	LinStatic	-771.89	1076.54	465.32
239	239	Shell-Thin	256	siloh	LinStatic	-771.89	1076.54	465.32
240	240	Shell-Thin	242	siloh	LinStatic	-771.90	1076.54	465.32
241	241	Shell-Thin	258	siloh	LinStatic	2196.12	135.53	56.91
242	242	Shell-Thin	257	siloh	LinStatic	2196.12	135.53	56.91
243	243	Shell-Thin	259	siloh	LinStatic	2196.12	135.53	56.91
244	244	Shell-Thin	260	siloh	LinStatic	2196.12	135.53	56.91
245	245	Shell-Thin	261	siloh	LinStatic	2196.12	135.53	56.91
246	246	Shell-Thin	262	siloh	LinStatic	2196.12	135.53	56.91
247	247	Shell-Thin	263	siloh	LinStatic	2196.12	135.53	56.91
248	248	Shell-Thin	264	siloh	LinStatic	2196.12	135.53	56.91
249	249	Shell-Thin	265	siloh	LinStatic	2196.12	135.53	56.91
250	250	Shell-Thin	266	siloh	LinStatic	2196.12	135.53	56.91
251	251	Shell-Thin	267	siloh	LinStatic	2196.12	135.53	56.91
252	252	Shell-Thin	268	siloh	LinStatic	2196.12	135.53	56.91
253	253	Shell-Thin	269	siloh	LinStatic	2196.12	135.53	56.91
254	254	Shell-Thin	270	siloh	LinStatic	2196.12	135.53	56.91
255	255	Shell-Thin	271	siloh	LinStatic	2196.12	135.53	56.91
256	256	Shell-Thin	272	siloh	LinStatic	2196.12	135.53	56.91

Appendix C



SAP2000 Analysis Report

Model Name: Sean grain silo .SDB

C1. Properties

C1. 1Material properties

This section provides material property information for materials used in the model.

Table C1: Material Properties

Material	UnitWeight	UnitMass	E1	G12	U12	A1
	N/m3	Kg/m3	N/m2	N/m2		1/C
4000Psi	2.3563E+04	2.4028E+03	2.486E+10	1.036E+10	0.200000	9.9000E-06

C1.2 sections

a. Frames

Table CCa: Frame Section Properties

Section Name	Material	Shape
silo column	4000Psi	Circle

b. Areas

TableCCb: Area Section Properties

Section	Material	MatAngle	AreaType	Type	DrillDOF	Thickness
		Degrees				m
roof	4000 Psi	0.000	Shell	Shell-Thin	Yes	0.300 000
silo	4000 Psi	0.000	Shell	Shell-Thin	Yes	0.300 000

C2. Load patterns

This section provides loading information as applied to the model.

C2.1. Definitions

Table C2: Load Pattern Definitions

LoadPat	DesignType	SelfWtMult
Siloh	HOR EARTH PR	0.000 000

C3. Structure results

This section provides structure results, including items such as structural periods and base reactions.

C3.1 element stresses

Table C3 element stresses

area	Area element	Shell type	joint	Output case	Case type	S11 N/m2	S22 N/m2	S12 N/m2
1	1	Shell-Thin	1	siloh	LinStatic	1405362.87	-45090.33	5849.04
2	2	Shell-Thin	5	siloh	LinStatic	1411506.90	-42846.72	-3096.90
3	3	Shell-Thin	5	siloh	LinStatic	1404581.64	-44969.77	5983.12
4	4	Shell-Thin	9	siloh	LinStatic	1411872.74	-42775.96	-3087.38
5	5	Shell-Thin	9	siloh	LinStatic	1404833.47	-44961.50	5996.64
6	6	Shell-Thin	13	siloh	LinStatic	1411890.12	-42861.67	-3038.63
7	7	Shell-Thin	13	siloh	LinStatic	1404916.67	-45030.15	5924.45
8	8	Shell-Thin	17	siloh	LinStatic	1411837.16	-42877.05	-3032.82
9	9	Shell-Thin	17	siloh	LinStatic	1404853.17	-45038.05	5928.50
10	10	Shell-Thin	21	siloh	LinStatic	1411904.00	-42869.15	-3028.12
11	11	Shell-Thin	21	siloh	LinStatic	1404906.26	-45023.57	5934.47
12	12	Shell-Thin	25	siloh	LinStatic	1411828.07	-42797.26	-3098.37
13	13	Shell-Thin	25	siloh	LinStatic	1404890.62	-44937.25	5981.62
14	14	Shell-Thin	29	siloh	LinStatic	1411559.37	-42808.70	-3090.39
15	15	Shell-Thin	29	siloh	LinStatic	1404508.00	-45011.08	5995.85
16	16	Shell-Thin	1	siloh	LinStatic	1412343.12	-42931.11	-2952.98
17	17	Shell-Thin	4	siloh	LinStatic	1359719.26	34012.26	-4789.62
18	18	Shell-Thin	6	siloh	LinStatic	1354928.49	32709.60	4924.66
19	19	Shell-Thin	6	siloh	LinStatic	1359000.69	33951.92	-4795.03
20	20	Shell-Thin	10	siloh	LinStatic	1355220.56	32762.09	4965.19
21	21	Shell-Thin	10	siloh	LinStatic	1359298.76	34018.48	-4767.60
22	22	Shell-Thin	14	siloh	LinStatic	1355236.63	32729.27	4923.91
23	23	Shell-Thin	14	siloh	LinStatic	1359328.95	33995.21	-4799.66
24	24	Shell-Thin	18	siloh	LinStatic	1355184.51	32714.48	4942.93
25	25	Shell-Thin	18	siloh	LinStatic	1359265.18	33969.97	-4787.84
26	26	Shell-Thin	22	siloh	LinStatic	1355250.04	32738.88	4955.85
27	27	Shell-Thin	22	siloh	LinStatic	1359319.81	33983.87	-4769.75
28	28	Shell-Thin	26	siloh	LinStatic	1355222.03	32764.66	4926.00
29	29	Shell-Thin	26	siloh	LinStatic	1359303.40	34017.28	-4807.43

30	30	Shell-Thin	30	siloh	LinStatic	1354913.88	32697.00	4951.61
31	31	Shell-Thin	30	siloh	LinStatic	1359002.42	33964.31	-4765.15
32	32	Shell-Thin	4	siloh	LinStatic	1355637.58	32755.84	4940.66
33	33	Shell-Thin	34	siloh	LinStatic	1280078.79	14283.51	-3035.80
34	34	Shell-Thin	33	siloh	LinStatic	1266745.38	34996.76	4001.72
34	34	Shell-Thin	35	siloh	LinStatic	1280268.25	14568.76	3286.96
34	34	Shell-Thin	51	siloh	LinStatic	1192735.94	-9970.25	2818.61
34	34	Shell-Thin	49	siloh	LinStatic	1187717.57	6381.73	3533.37
35	35	Shell-Thin	35	siloh	LinStatic	1279390.38	14174.05	-2981.70
36	36	Shell-Thin	37	siloh	LinStatic	1280580.30	14661.06	3327.50
37	37	Shell-Thin	37	siloh	LinStatic	1279674.51	14253.34	-2946.64
38	38	Shell-Thin	39	siloh	LinStatic	1280597.88	14637.08	3318.42
39	39	Shell-Thin	39	siloh	LinStatic	1279688.97	14229.31	-3005.91
40	40	Shell-Thin	41	siloh	LinStatic	1280528.09	14608.53	3335.08
41	41	Shell-Thin	41	siloh	LinStatic	1279628.66	14204.47	-2997.32
42	42	Shell-Thin	43	siloh	LinStatic	1280588.95	14630.98	3344.76
43	43	Shell-Thin	43	siloh	LinStatic	1279698.94	14230.79	-2982.10
44	44	Shell-Thin	45	siloh	LinStatic	1280574.96	14656.29	3288.14
45	45	Shell-Thin	45	siloh	LinStatic	1279684.43	14256.46	-2987.94
46	46	Shell-Thin	47	siloh	LinStatic	1280284.73	14581.40	3319.67
47	47	Shell-Thin	47	siloh	LinStatic	1279366.39	14168.37	-2943.71
48	48	Shell-Thin	34	siloh	LinStatic	1280980.13	14687.73	3369.28
49	49	Shell-Thin	50	siloh	LinStatic	1197210.68	6998.76	-2678.76
50	50	Shell-Thin	51	siloh	LinStatic	1196065.79	6679.00	2558.09
51	51	Shell-Thin	51	siloh	LinStatic	1196552.86	6877.13	-2659.43
52	52	Shell-Thin	53	siloh	LinStatic	1196377.31	6776.17	2616.13
53	53	Shell-Thin	53	siloh	LinStatic	1196843.07	6975.67	-2628.44
54	54	Shell-Thin	55	siloh	LinStatic	1196372.26	6740.14	2584.83
55	55	Shell-Thin	55	siloh	LinStatic	1196843.79	6943.39	-2668.44
56	56	Shell-Thin	57	siloh	LinStatic	1196303.02	6718.02	2596.51
57	57	Shell-Thin	57	siloh	LinStatic	1196776.54	6918.45	-2656.29
58	58	Shell-Thin	59	siloh	LinStatic	1196370.10	6741.39	2609.01
59	59	Shell-Thin	59	siloh	LinStatic	1196845.04	6938.71	-2645.19
60	60	Shell-Thin	61	siloh	LinStatic	1196370.79	6774.61	2571.31

61	61	Shell-Thin	61	siloh	LinStatic	1196852.34	6975.10	-2674.09
62	62	Shell-Thin	63	siloh	LinStatic	1196077.37	6680.13	2600.92
63	63	Shell-Thin	63	siloh	LinStatic	1196538.31	6882.44	-2614.51
64	64	Shell-Thin	50	siloh	LinStatic	1196738.25	6798.24	2615.53
65	65	Shell-Thin	65	siloh	LinStatic	1110973.96	19057.74	-2182.30
66	66	Shell-Thin	67	siloh	LinStatic	1111101.95	4709.63	2007.67
67	67	Shell-Thin	67	siloh	LinStatic	1110970.85	4637.85	-1998.87
68	68	Shell-Thin	69	siloh	LinStatic	1111409.05	4814.03	2072.03
69	69	Shell-Thin	69	siloh	LinStatic	1111250.77	4734.26	-1966.71
70	70	Shell-Thin	71	siloh	LinStatic	1111395.25	4780.36	2047.77
71	71	Shell-Thin	71	siloh	LinStatic	1111241.84	4703.19	-2011.52
72	72	Shell-Thin	73	siloh	LinStatic	1111327.56	4763.59	2056.90
73	73	Shell-Thin	73	siloh	LinStatic	1111178.56	4687.11	-2000.48
74	74	Shell-Thin	75	siloh	LinStatic	1111390.05	4778.49	2068.46
75	75	Shell-Thin	75	siloh	LinStatic	1111245.36	4702.68	-1991.97
76	76	Shell-Thin	77	siloh	LinStatic	1111400.11	4809.91	2025.71
77	77	Shell-Thin	77	siloh	LinStatic	1111261.43	4736.53	-2014.03
78	78	Shell-Thin	79	siloh	LinStatic	1111118.97	4716.91	2056.06
79	79	Shell-Thin	80	siloh	LinStatic	1110990.96	19057.29	-2054.19
80	80	Shell-Thin	66	siloh	LinStatic	1111748.52	4851.37	2087.91
81	81	Shell-Thin	81	siloh	LinStatic	1028505.63	17679.46	-1553.50
82	82	Shell-Thin	81	siloh	LinStatic	1028481.50	17657.13	1410.88
83	83	Shell-Thin	84	siloh	LinStatic	1028406.87	17526.01	-1476.70
84	84	Shell-Thin	84	siloh	LinStatic	1028344.73	17479.91	1498.19
85	85	Shell-Thin	86	siloh	LinStatic	1028522.94	17619.05	-1479.34
86	86	Shell-Thin	86	siloh	LinStatic	1028480.38	17579.98	1477.77
87	87	Shell-Thin	88	siloh	LinStatic	1028476.81	17637.81	-1506.70
88	88	Shell-Thin	88	siloh	LinStatic	1028431.01	17599.17	1470.56
89	89	Shell-Thin	90	siloh	LinStatic	1028478.08	17638.60	-1491.84
90	90	Shell-Thin	90	siloh	LinStatic	1028430.42	17599.56	1485.67
91	91	Shell-Thin	92	siloh	LinStatic	1028527.59	17623.23	-1498.99
92	92	Shell-Thin	92	siloh	LinStatic	1028476.47	17584.41	1459.65
93	93	Shell-Thin	94	siloh	LinStatic	1028390.94	17517.78	-1518.70
94	94	Shell-Thin	94	siloh	LinStatic	1028359.03	17485.87	1455.80

95	95	Shell-Thin	96	siloh	LinStatic	1028528.90	17687.70	-1430.43
96	96	Shell-Thin	96	siloh	LinStatic	1028459.71	17632.40	1530.95
97	97	Shell-Thin	97	siloh	LinStatic	943904.95	17353.61	-1075.97
98	98	Shell-Thin	97	siloh	LinStatic	943950.28	17386.03	954.07
99	99	Shell-Thin	100	siloh	LinStatic	943830.64	17218.14	-989.78
100	100	Shell-Thin	100	siloh	LinStatic	943833.95	17225.99	1046.53
101	101	Shell-Thin	102	siloh	LinStatic	943927.50	17294.51	-998.17
102	102	Shell-Thin	102	siloh	LinStatic	943952.84	17313.32	1024.34
103	103	Shell-Thin	104	siloh	LinStatic	943889.56	17310.73	-1024.59
104	104	Shell-Thin	104	siloh	LinStatic	943911.27	17328.70	1017.33
105	105	Shell-Thin	121	siloh	LinStatic	848578.00	-8803.34	-737.68
106	106	Shell-Thin	106	siloh	LinStatic	943910.20	17328.02	1033.28
107	107	Shell-Thin	108	siloh	LinStatic	943933.38	17300.29	-1015.69
108	108	Shell-Thin	108	siloh	LinStatic	943948.37	17314.95	1008.23
109	109	Shell-Thin	110	siloh	LinStatic	943813.13	17208.50	-1037.13
110	110	Shell-Thin	110	siloh	LinStatic	943849.74	17233.88	998.82
111	111	Shell-Thin	112	siloh	LinStatic	943929.92	17361.86	-944.05
112	112	Shell-Thin	112	siloh	LinStatic	943925.32	17363.32	1083.21
113	113	Shell-Thin	113	siloh	LinStatic	856976.09	17143.75	-737.13
114	114	Shell-Thin	113	siloh	LinStatic	856999.29	17156.58	592.46
115	115	Shell-Thin	116	siloh	LinStatic	856933.91	17022.76	-646.25
116	116	Shell-Thin	116	siloh	LinStatic	856909.52	17007.08	694.12
117	117	Shell-Thin	118	siloh	LinStatic	857016.32	17087.35	-659.23
118	118	Shell-Thin	118	siloh	LinStatic	857009.99	17080.79	667.23
119	119	Shell-Thin	120	siloh	LinStatic	856984.34	17100.84	-681.39
120	120	Shell-Thin	120	siloh	LinStatic	856975.42	17094.24	658.92
121	121	Shell-Thin	122	siloh	LinStatic	856985.51	17101.74	-664.57
122	122	Shell-Thin	122	siloh	LinStatic	856974.91	17093.82	675.81
123	123	Shell-Thin	124	siloh	LinStatic	857020.71	17091.34	-672.50
124	124	Shell-Thin	124	siloh	LinStatic	857007.42	17083.13	654.98
125	125	Shell-Thin	126	siloh	LinStatic	856918.66	17013.92	-698.75
126	126	Shell-Thin	126	siloh	LinStatic	856923.09	17014.64	641.49
127	127	Shell-Thin	128	siloh	LinStatic	857008.47	17157.48	-596.99
128	128	Shell-Thin	128	siloh	LinStatic	856965.90	17130.21	730.37

129	129	Shell-Thin	129	siloh	LinStatic	767433.08	16910.08	-471.25
130	130	Shell-Thin	129	siloh	LinStatic	767482.61	16937.86	315.02
131	131	Shell-Thin	132	siloh	LinStatic	767442.23	16814.80	-367.97
132	132	Shell-Thin	132	siloh	LinStatic	767435.96	16809.93	425.10
133	133	Shell-Thin	134	siloh	LinStatic	767511.26	16871.48	-382.49
134	134	Shell-Thin	134	siloh	LinStatic	767517.44	16875.72	397.21
135	135	Shell-Thin	136	siloh	LinStatic	767482.90	16881.24	-404.08
136	136	Shell-Thin	136	siloh	LinStatic	767487.98	16885.33	388.70
137	137	Shell-Thin	138	siloh	LinStatic	767484.25	16882.34	-386.65
138	138	Shell-Thin	138	siloh	LinStatic	767487.20	16884.46	406.17
139	139	Shell-Thin	140	siloh	LinStatic	767514.45	16875.41	-394.68
140	140	Shell-Thin	140	siloh	LinStatic	767516.20	16877.08	385.90
141	141	Shell-Thin	142	siloh	LinStatic	767431.39	16806.64	-421.90
142	142	Shell-Thin	142	siloh	LinStatic	767445.29	16817.21	371.09
143	143	Shell-Thin	144	siloh	LinStatic	767477.71	16929.28	-312.05
144	144	Shell-Thin	144	siloh	LinStatic	767436.34	16907.78	472.27
145	145	Shell-Thin	145	siloh	LinStatic	675235.20	17129.97	-273.35
146	146	Shell-Thin	145	siloh	LinStatic	675305.79	17161.91	83.59
147	147	Shell-Thin	148	siloh	LinStatic	675328.10	17109.13	-143.92
148	148	Shell-Thin	148	siloh	LinStatic	675320.05	17099.58	206.25
149	149	Shell-Thin	150	siloh	LinStatic	675379.32	17162.27	-165.82
150	150	Shell-Thin	150	siloh	LinStatic	675377.66	17161.94	175.06
151	151	Shell-Thin	152	siloh	LinStatic	675354.92	17168.86	-185.74
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153	153	Shell-Thin	154	siloh	LinStatic	675355.56	17169.64	-167.70
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155	155	Shell-Thin	156	siloh	LinStatic	675380.27	17165.40	-176.32
156	156	Shell-Thin	156	siloh	LinStatic	675378.66	17163.18	165.22
157	157	Shell-Thin	158	siloh	LinStatic	675321.16	17100.67	-206.87
158	158	Shell-Thin	158	siloh	LinStatic	675325.67	17107.46	143.34
159	159	Shell-Thin	160	siloh	LinStatic	675306.36	17158.41	-84.78
160	160	Shell-Thin	160	siloh	LinStatic	675232.67	17124.27	270.53
161	161	Shell-Thin	161	siloh	LinStatic	580153.32	18293.84	-132.70
162	162	Shell-Thin	161	siloh	LinStatic	580259.58	18337.05	-78.61

163	163	Shell-Thin	164	siloh	LinStatic	580359.78	18482.44	22.72
164	164	Shell-Thin	164	siloh	LinStatic	580339.97	18469.96	58.21
165	165	Shell-Thin	166	siloh	LinStatic	580365.19	18501.31	-9.98
166	166	Shell-Thin	166	siloh	LinStatic	580367.79	18503.41	18.46
167	167	Shell-Thin	168	siloh	LinStatic	580349.28	18512.84	-28.59
168	168	Shell-Thin	168	siloh	LinStatic	580349.37	18514.70	11.12
169	169	Shell-Thin	170	siloh	LinStatic	580348.90	18514.12	-10.95
170	170	Shell-Thin	170	siloh	LinStatic	580350.11	18513.41	28.71
171	171	Shell-Thin	172	siloh	LinStatic	580368.08	18504.77	-17.63
172	172	Shell-Thin	172	siloh	LinStatic	580366.72	18503.52	11.34
173	173	Shell-Thin	174	siloh	LinStatic	580338.91	18469.45	-56.72
174	174	Shell-Thin	174	siloh	LinStatic	580359.71	18482.55	-21.16
175	175	Shell-Thin	176	siloh	LinStatic	580257.84	18332.63	79.28
176	176	Shell-Thin	176	siloh	LinStatic	580152.99	18290.65	131.97
177	177	Shell-Thin	177	siloh	LinStatic	481494.33	20264.92	-98.61
178	178	Shell-Thin	177	siloh	LinStatic	481595.55	20292.09	-80.75
179	179	Shell-Thin	180	siloh	LinStatic	481732.39	20797.37	84.09
180	180	Shell-Thin	180	siloh	LinStatic	481668.57	20774.93	40.17
181	181	Shell-Thin	182	siloh	LinStatic	481669.79	20728.20	10.00
182	182	Shell-Thin	182	siloh	LinStatic	481678.55	20727.73	-7.24
183	183	Shell-Thin	184	siloh	LinStatic	481658.31	20744.27	-3.65
184	184	Shell-Thin	184	siloh	LinStatic	481660.18	20744.94	-17.14
185	185	Shell-Thin	186	siloh	LinStatic	481660.53	20745.07	16.27
186	186	Shell-Thin	186	siloh	LinStatic	481658.26	20744.20	2.70
187	187	Shell-Thin	188	siloh	LinStatic	481679.61	20729.49	7.10
188	188	Shell-Thin	188	siloh	LinStatic	481670.39	20729.46	-9.75
189	189	Shell-Thin	190	siloh	LinStatic	481668.42	20775.08	-39.67
190	190	Shell-Thin	190	siloh	LinStatic	481731.57	20796.81	-83.46
191	191	Shell-Thin	192	siloh	LinStatic	481594.68	20288.97	80.23
192	192	Shell-Thin	192	siloh	LinStatic	481493.16	20261.69	96.88
193	193	Shell-Thin	193	siloh	LinStatic	378041.63	21008.10	-201.93
194	194	Shell-Thin	193	siloh	LinStatic	377942.76	20948.62	239.49
195	195	Shell-Thin	196	siloh	LinStatic	377911.00	21697.14	-146.53
196	196	Shell-Thin	196	siloh	LinStatic	377818.08	21685.50	255.64

197	197	Shell-Thin	198	siloh	LinStatic	377853.13	21563.03	-218.87
198	198	Shell-Thin	198	siloh	LinStatic	377845.90	21561.86	229.90
199	199	Shell-Thin	200	siloh	LinStatic	377822.26	21556.06	-236.95
200	200	Shell-Thin	200	siloh	LinStatic	377826.45	21556.90	215.83
201	201	Shell-Thin	202	siloh	LinStatic	377826.46	21556.90	-216.14
202	202	Shell-Thin	202	siloh	LinStatic	377822.46	21556.38	236.56
203	203	Shell-Thin	204	siloh	LinStatic	377846.50	21563.22	-229.50
204	204	Shell-Thin	204	siloh	LinStatic	377853.90	21564.43	219.59
205	205	Shell-Thin	206	siloh	LinStatic	377817.71	21685.29	-254.62
206	206	Shell-Thin	206	siloh	LinStatic	377910.65	21696.75	147.71
207	207	Shell-Thin	208	siloh	LinStatic	377941.71	20945.68	-239.56
208	208	Shell-Thin	208	siloh	LinStatic	378040.85	21005.56	200.84
209	209	Shell-Thin	209	siloh	LinStatic	269002.14	15437.44	-514.54
210	210	Shell-Thin	209	siloh	LinStatic	268241.83	15133.76	970.00
211	211	Shell-Thin	212	siloh	LinStatic	267661.71	15005.83	-747.41
212	212	Shell-Thin	212	siloh	LinStatic	267744.46	15016.68	747.04
213	213	Shell-Thin	214	siloh	LinStatic	267814.82	15047.77	-773.83
214	214	Shell-Thin	214	siloh	LinStatic	267776.43	15057.47	790.96
215	215	Shell-Thin	216	siloh	LinStatic	267782.98	15042.28	-805.35
216	216	Shell-Thin	216	siloh	LinStatic	267775.45	15046.85	783.50
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218	218	Shell-Thin	218	siloh	LinStatic	267782.88	15042.58	804.71
219	219	Shell-Thin	220	siloh	LinStatic	267776.76	15058.83	-790.85
220	220	Shell-Thin	220	siloh	LinStatic	267815.19	15049.00	774.20
221	221	Shell-Thin	222	siloh	LinStatic	267744.29	15016.45	-746.36
222	222	Shell-Thin	222	siloh	LinStatic	267661.62	15005.31	748.24
223	223	Shell-Thin	224	siloh	LinStatic	268241.35	15131.17	-970.32
224	224	Shell-Thin	224	siloh	LinStatic	269001.50	15435.01	513.25
225	225	Shell-Thin	226	siloh	LinStatic	157078.26	-2105.51	1419.42
226	226	Shell-Thin	225	siloh	LinStatic	154642.58	-4480.44	1547.22
227	227	Shell-Thin	228	siloh	LinStatic	153859.73	-7097.22	-1607.21
228	228	Shell-Thin	228	siloh	LinStatic	154245.54	-7103.20	1301.86
229	229	Shell-Thin	230	siloh	LinStatic	154039.77	-7083.49	-1409.91
230	230	Shell-Thin	230	siloh	LinStatic	154121.21	-7111.30	1368.56

231	231	Shell-Thin	232	siloh	LinStatic	154084.07	-7043.54	-1417.29
232	232	Shell-Thin	232	siloh	LinStatic	154097.51	-7050.67	1393.10
233	233	Shell-Thin	234	siloh	LinStatic	154097.34	-7050.57	-1393.40
234	234	Shell-Thin	234	siloh	LinStatic	154083.58	-7043.37	1416.99
235	235	Shell-Thin	236	siloh	LinStatic	154120.70	-7110.68	-1368.39
236	236	Shell-Thin	236	siloh	LinStatic	154039.50	-7082.89	1410.36
237	237	Shell-Thin	238	siloh	LinStatic	154245.57	-7103.27	-1301.20
238	238	Shell-Thin	238	siloh	LinStatic	153860.31	-7097.37	1607.96
239	239	Shell-Thin	240	siloh	LinStatic	154643.28	-4481.93	-1547.29
240	240	Shell-Thin	226	siloh	LinStatic	157078.93	-2105.63	-1420.19
241	241	Shell-Thin	241	siloh	LinStatic	39009.34	-48301.40	6023.78
242	242	Shell-Thin	243	siloh	LinStatic	36239.22	-48129.39	7218.79
243	243	Shell-Thin	243	siloh	LinStatic	37430.82	-47551.54	-5999.72
244	244	Shell-Thin	245	siloh	LinStatic	36986.32	-48622.84	6272.07
245	245	Shell-Thin	245	siloh	LinStatic	37164.79	-48407.21	-6118.66
246	246	Shell-Thin	247	siloh	LinStatic	37075.99	-48583.86	6090.75
247	247	Shell-Thin	247	siloh	LinStatic	37098.77	-48519.52	-6063.06
248	248	Shell-Thin	249	siloh	LinStatic	37071.94	-48533.39	6045.59
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251	251	Shell-Thin	251	siloh	LinStatic	37074.43	-48584.96	-6090.82
252	252	Shell-Thin	253	siloh	LinStatic	37163.95	-48407.45	6119.06
253	253	Shell-Thin	253	siloh	LinStatic	36986.23	-48623.36	-6271.59
254	254	Shell-Thin	255	siloh	LinStatic	37432.50	-47549.86	6000.14
255	255	Shell-Thin	255	siloh	LinStatic	36241.70	-48127.91	-7218.56
256	256	Shell-Thin	256	siloh	LinStatic	39011.39	-48298.54	-6024.44
257	257	Shell-Thin	258	siloh	LinStatic	10545.97	-47433.02	-6137.17
258	258	Shell-Thin	257	siloh	LinStatic	9437.57	-58549.62	-3897.36
259	259	Shell-Thin	260	siloh	LinStatic	3646.13	-62649.73	5564.93
260	260	Shell-Thin	260	siloh	LinStatic	3585.13	-62239.02	-5512.76
261	261	Shell-Thin	277	siloh	LinStatic	-11656.70	-48545.06	-3254.79
262	262	Shell-Thin	262	siloh	LinStatic	3395.39	-62835.90	-5438.84
263	263	Shell-Thin	264	siloh	LinStatic	3386.50	-62944.67	5417.64
264	264	Shell-Thin	264	siloh	LinStatic	3378.51	-62914.25	-5410.21

265	265	Shell-Thin	266	siloh	LinStatic	3378.32	-62914.28	5409.90
266	266	Shell-Thin	266	siloh	LinStatic	3385.85	-62944.46	-5417.88
267	267	Shell-Thin	268	siloh	LinStatic	3394.47	-62835.82	5438.86
268	268	Shell-Thin	268	siloh	LinStatic	3421.39	-62959.58	-5494.53
269	269	Shell-Thin	270	siloh	LinStatic	3585.23	-62238.82	5513.28
270	270	Shell-Thin	270	siloh	LinStatic	3646.98	-62649.93	-5564.45
271	271	Shell-Thin	272	siloh	LinStatic	9438.82	-58550.01	3897.37
272	272	Shell-Thin	258	siloh	LinStatic	10546.66	-47433.44	6136.28
273	273	Shell-Thin	274	siloh	LinStatic	-7623.20	-42244.84	-2975.32
274	274	Shell-Thin	273	siloh	LinStatic	-10507.59	-45862.39	-3326.99
275	275	Shell-Thin	276	siloh	LinStatic	-11649.72	-49072.51	3486.38
276	276	Shell-Thin	277	siloh	LinStatic	-11632.80	-49061.80	3483.52
277	277	Shell-Thin	278	siloh	LinStatic	-11721.15	-49051.92	3349.46
278	278	Shell-Thin	278	siloh	LinStatic	-11692.22	-49149.48	-3390.98
279	279	Shell-Thin	280	siloh	LinStatic	-11700.33	-49056.25	3392.58
280	280	Shell-Thin	280	siloh	LinStatic	-11699.79	-49082.72	-3402.09
281	281	Shell-Thin	282	siloh	LinStatic	-11699.77	-49082.38	3401.84
282	282	Shell-Thin	282	siloh	LinStatic	-11700.66	-49055.74	-3392.72
283	283	Shell-Thin	284	siloh	LinStatic	-11692.54	-49148.68	3390.97
284	284	Shell-Thin	284	siloh	LinStatic	-11721.21	-49051.25	-3349.19
285	285	Shell-Thin	285	siloh	LinStatic	-11632.56	-49061.71	-3483.15
286	286	Shell-Thin	286	siloh	LinStatic	-11649.24	-49073.12	-3486.09
287	287	Shell-Thin	288	siloh	LinStatic	-10507.17	-45863.69	3326.95
288	288	Shell-Thin	274	siloh	LinStatic	-7622.63	-42245.09	2974.79
289	289	Shell-Thin	306	siloh	LinStatic	-8095.42	-8147.42	-366.13
290	290	Shell-Thin	305	siloh	LinStatic	-9048.98	-8475.24	-542.74
291	291	Shell-Thin	308	siloh	LinStatic	-9436.78	-8470.91	267.49
292	292	Shell-Thin	309	siloh	LinStatic	-9425.39	-8545.68	352.35
293	293	Shell-Thin	310	siloh	LinStatic	-9426.62	-8461.31	353.99
294	294	Shell-Thin	310	siloh	LinStatic	-9423.03	-8541.64	-359.94
295	295	Shell-Thin	311	siloh	LinStatic	-9432.90	-8426.27	-399.47
296	296	Shell-Thin	313	siloh	LinStatic	-9435.20	-8455.28	398.04
297	297	Shell-Thin	313	siloh	LinStatic	-9435.26	-8455.22	-398.18
298	298	Shell-Thin	315	siloh	LinStatic	-9432.69	-8425.48	399.33

299	299	Shell-Thin	316	siloh	LinStatic	-9422.82	-8540.82	359.95
300	300	Shell-Thin	316	siloh	LinStatic	-9426.32	-8460.58	-353.82
301	301	Shell-Thin	317	siloh	LinStatic	-9425.19	-8545.52	-352.10
302	302	Shell-Thin	318	siloh	LinStatic	-9436.79	-8471.52	-267.30
303	303	Shell-Thin	320	siloh	LinStatic	-9049.33	-8476.38	542.67
304	304	Shell-Thin	306	siloh	LinStatic	-8095.26	-8147.54	365.80
305	305	Shell-Thin	322	siloh	LinStatic	-3423.81	1582.76	70.19
306	306	Shell-Thin	321	siloh	LinStatic	-4033.72	1399.12	115.75
307	307	Shell-Thin	324	siloh	LinStatic	-4089.88	1499.53	-285.69
308	308	Shell-Thin	325	siloh	LinStatic	-4105.69	1724.03	-267.96
309	309	Shell-Thin	326	siloh	LinStatic	-4092.25	1684.07	-197.49
310	310	Shell-Thin	326	siloh	LinStatic	-4093.61	1767.60	170.13
311	311	Shell-Thin	327	siloh	LinStatic	-4099.04	1693.07	226.21
312	312	Shell-Thin	328	siloh	LinStatic	-4104.49	1734.70	183.37
313	313	Shell-Thin	330	siloh	LinStatic	-4104.35	1735.04	-183.54
314	314	Shell-Thin	331	siloh	LinStatic	-4098.80	1693.76	-226.33
315	315	Shell-Thin	332	siloh	LinStatic	-4093.36	1768.28	-170.10
316	316	Shell-Thin	332	siloh	LinStatic	-4091.94	1684.69	197.65
317	317	Shell-Thin	333	siloh	LinStatic	-4105.50	1724.15	268.18
318	318	Shell-Thin	334	siloh	LinStatic	-4089.95	1499.02	285.86
319	319	Shell-Thin	336	siloh	LinStatic	-4034.12	1398.16	-115.83
320	320	Shell-Thin	322	siloh	LinStatic	-3423.70	1582.67	-70.49
320	320	Shell-Thin	336	siloh	LinStatic	-3955.73	1189.38	319.69
321	321	Shell-Thin	338	siloh	LinStatic	-43.81	4586.54	346.20
322	322	Shell-Thin	337	siloh	LinStatic	-405.13	4459.35	345.70
323	323	Shell-Thin	340	siloh	LinStatic	-490.43	4573.55	-330.63
324	324	Shell-Thin	341	siloh	LinStatic	-371.95	4680.62	-387.01
325	325	Shell-Thin	342	siloh	LinStatic	-395.86	4775.90	-368.73
326	326	Shell-Thin	343	siloh	LinStatic	-386.20	4762.67	-331.34
327	327	Shell-Thin	343	siloh	LinStatic	-391.20	4803.52	319.86
328	328	Shell-Thin	345	siloh	LinStatic	-398.92	4778.06	-323.93
329	329	Shell-Thin	345	siloh	LinStatic	-398.98	4778.13	323.75
330	330	Shell-Thin	347	siloh	LinStatic	-390.93	4804.17	-319.97
331	331	Shell-Thin	347	siloh	LinStatic	-385.96	4763.34	331.38

332	332	Shell-Thin	348	siloh	LinStatic	-395.53	4776.47	368.92
333	333	Shell-Thin	349	siloh	LinStatic	-371.75	4680.73	387.27
334	334	Shell-Thin	350	siloh	LinStatic	-490.51	4573.04	330.82
335	335	Shell-Thin	352	siloh	LinStatic	-405.53	4458.51	-345.81
336	336	Shell-Thin	338	siloh	LinStatic	-43.70	4586.44	-346.51
337	337	Shell-Thin	354	siloh	LinStatic	1378.21	3743.98	192.83
338	338	Shell-Thin	353	siloh	LinStatic	1077.49	3611.57	290.99
339	339	Shell-Thin	356	siloh	LinStatic	913.53	3432.75	-205.07
340	340	Shell-Thin	357	siloh	LinStatic	1065.38	3622.87	-265.94
341	341	Shell-Thin	358	siloh	LinStatic	1099.36	3666.56	-274.64
342	342	Shell-Thin	358	siloh	LinStatic	1086.44	3729.65	199.18
343	343	Shell-Thin	359	siloh	LinStatic	1089.99	3695.32	248.14
344	344	Shell-Thin	360	siloh	LinStatic	1080.38	3718.10	227.84
345	345	Shell-Thin	362	siloh	LinStatic	1080.59	3718.48	-228.09
346	346	Shell-Thin	363	siloh	LinStatic	1090.30	3696.04	-248.26
347	347	Shell-Thin	364	siloh	LinStatic	1086.73	3730.34	-199.09
348	348	Shell-Thin	364	siloh	LinStatic	1099.74	3667.15	274.87
349	349	Shell-Thin	365	siloh	LinStatic	1065.62	3622.95	266.25
350	350	Shell-Thin	366	siloh	LinStatic	913.43	3432.18	205.28
351	351	Shell-Thin	368	siloh	LinStatic	1077.08	3610.70	-291.14
352	352	Shell-Thin	354	siloh	LinStatic	1378.33	3743.90	-193.18
353	353	Shell-Thin	354	siloh	LinStatic	1350.43	3615.61	210.09
354	354	Shell-Thin	369	siloh	LinStatic	1080.26	1576.61	132.67
355	355	Shell-Thin	356	siloh	LinStatic	914.50	3436.88	-189.29
356	356	Shell-Thin	357	siloh	LinStatic	1053.31	3563.36	-289.67
357	357	Shell-Thin	358	siloh	LinStatic	1093.27	3635.12	-289.45
358	358	Shell-Thin	359	siloh	LinStatic	1080.40	3687.08	-294.91
359	359	Shell-Thin	359	siloh	LinStatic	1088.74	3689.50	255.96
360	360	Shell-Thin	361	siloh	LinStatic	1076.23	3686.70	-272.37
361	361	Shell-Thin	361	siloh	LinStatic	1076.17	3686.82	272.09
362	362	Shell-Thin	363	siloh	LinStatic	1089.06	3690.24	-256.08
363	363	Shell-Thin	363	siloh	LinStatic	1080.69	3687.84	294.97
364	364	Shell-Thin	364	siloh	LinStatic	1093.64	3635.69	289.72
365	365	Shell-Thin	365	siloh	LinStatic	1053.53	3563.37	290.02

366	366	Shell-Thin	366	siloh	LinStatic	914.38	3436.24	189.52
367	367	Shell-Thin	384	siloh	LinStatic	1079.80	1575.71	-132.85
368	368	Shell-Thin	354	siloh	LinStatic	1350.54	3615.45	-210.47
369	369	Shell-Thin	370	siloh	LinStatic	1300.70	1543.49	66.02
370	370	Shell-Thin	369	siloh	LinStatic	1082.24	1505.50	83.43
371	371	Shell-Thin	372	siloh	LinStatic	780.72	1298.27	1.22
372	372	Shell-Thin	373	siloh	LinStatic	967.00	1307.28	-54.10
373	373	Shell-Thin	374	siloh	LinStatic	1018.05	1414.46	-124.39
374	374	Shell-Thin	375	siloh	LinStatic	1031.25	1461.05	-99.29
375	375	Shell-Thin	375	siloh	LinStatic	1023.43	1497.80	42.95
376	376	Shell-Thin	376	siloh	LinStatic	1024.89	1495.75	70.66
377	377	Shell-Thin	378	siloh	LinStatic	1025.18	1496.22	-71.00
378	378	Shell-Thin	379	siloh	LinStatic	1023.86	1498.66	-43.08
379	379	Shell-Thin	379	siloh	LinStatic	1031.64	1461.94	99.38
380	380	Shell-Thin	380	siloh	LinStatic	1018.51	1415.07	124.72
381	381	Shell-Thin	381	siloh	LinStatic	967.25	1307.23	54.51
382	382	Shell-Thin	382	siloh	LinStatic	780.54	1297.50	-0.98
383	383	Shell-Thin	384	siloh	LinStatic	1081.77	1504.58	-83.63
384	384	Shell-Thin	370	siloh	LinStatic	1300.83	1543.30	-66.45
385	385	Shell-Thin	386	siloh	LinStatic	704.33	49.27	-65.11
386	386	Shell-Thin	385	siloh	LinStatic	514.77	53.73	-20.45
387	387	Shell-Thin	387	siloh	LinStatic	241.42	-68.34	40.36
388	388	Shell-Thin	389	siloh	LinStatic	300.35	-210.95	57.48
389	389	Shell-Thin	390	siloh	LinStatic	405.54	-153.66	3.06
390	390	Shell-Thin	391	siloh	LinStatic	425.14	-63.30	-31.23
391	391	Shell-Thin	392	siloh	LinStatic	429.95	-21.96	2.35
392	392	Shell-Thin	393	siloh	LinStatic	429.64	1.46	14.80
393	393	Shell-Thin	393	siloh	LinStatic	429.54	1.66	-15.25
394	394	Shell-Thin	394	siloh	LinStatic	430.22	-21.11	-2.58
395	395	Shell-Thin	395	siloh	LinStatic	425.69	-62.27	31.36
396	396	Shell-Thin	396	siloh	LinStatic	406.13	-153.01	-2.65
397	397	Shell-Thin	397	siloh	LinStatic	300.61	-211.08	-57.01
398	398	Shell-Thin	399	siloh	LinStatic	240.64	-69.49	-40.22
399	399	Shell-Thin	400	siloh	LinStatic	514.23	52.75	20.21

400	400	Shell-Thin	386	siloh	LinStatic	704.46	49.06	64.65
401	401	Shell-Thin	402	siloh	LinStatic	247.89	-389.40	-67.28
402	402	Shell-Thin	401	siloh	LinStatic	97.56	-367.38	-78.36
403	403	Shell-Thin	403	siloh	LinStatic	-152.05	-414.44	15.84
404	404	Shell-Thin	405	siloh	LinStatic	-175.31	-606.31	98.71
405	405	Shell-Thin	406	siloh	LinStatic	-62.12	-580.19	22.95
406	406	Shell-Thin	407	siloh	LinStatic	-0.30	-494.10	-10.72
407	407	Shell-Thin	408	siloh	LinStatic	14.44	-405.57	-17.06
408	408	Shell-Thin	409	siloh	LinStatic	16.64	-363.55	30.90
409	409	Shell-Thin	409	siloh	LinStatic	16.52	-363.31	-31.42
410	410	Shell-Thin	410	siloh	LinStatic	14.83	-404.58	16.81
411	411	Shell-Thin	411	siloh	LinStatic	0.44	-492.94	10.88
412	412	Shell-Thin	412	siloh	LinStatic	-61.40	-579.52	-22.48
413	413	Shell-Thin	413	siloh	LinStatic	-175.05	-606.53	-98.22
414	414	Shell-Thin	415	siloh	LinStatic	-152.99	-415.63	-15.73
415	415	Shell-Thin	416	siloh	LinStatic	96.94	-368.38	78.09
416	416	Shell-Thin	402	siloh	LinStatic	248.03	-389.62	66.81
417	417	Shell-Thin	434	siloh	LinStatic	197.01	19.59	-42.89
418	418	Shell-Thin	433	siloh	LinStatic	108.39	68.43	-83.68
419	419	Shell-Thin	435	siloh	LinStatic	-41.00	108.59	-39.96
420	420	Shell-Thin	436	siloh	LinStatic	-145.12	44.08	46.17
421	421	Shell-Thin	438	siloh	LinStatic	-84.32	-20.18	37.91
422	422	Shell-Thin	439	siloh	LinStatic	30.19	9.64	-1.79
423	423	Shell-Thin	440	siloh	LinStatic	106.35	85.72	-14.05
424	424	Shell-Thin	441	siloh	LinStatic	121.56	116.19	4.86
425	425	Shell-Thin	441	siloh	LinStatic	121.44	116.24	-5.22
426	426	Shell-Thin	442	siloh	LinStatic	107.00	86.44	13.85
427	427	Shell-Thin	443	siloh	LinStatic	31.26	10.58	1.87
428	428	Shell-Thin	444	siloh	LinStatic	-83.45	-19.58	-37.63
429	429	Shell-Thin	446	siloh	LinStatic	-145.94	43.42	-45.96
430	430	Shell-Thin	447	siloh	LinStatic	-42.12	107.68	39.94
431	431	Shell-Thin	448	siloh	LinStatic	107.64	67.80	83.48
432	432	Shell-Thin	434	siloh	LinStatic	197.10	19.57	42.62
433	433	Shell-Thin	449	siloh	LinStatic	205.34	-18.55	-62.68

434	434	Shell-Thin	449	siloh	LinStatic	123.50	46.55	-138.16
435	435	Shell-Thin	451	siloh	LinStatic	16.61	75.79	-118.59
436	436	Shell-Thin	452	siloh	LinStatic	-51.95	71.65	-51.81
437	437	Shell-Thin	453	siloh	LinStatic	-43.69	11.02	74.47
438	438	Shell-Thin	455	siloh	LinStatic	34.31	45.27	116.31
439	439	Shell-Thin	456	siloh	LinStatic	133.23	50.99	97.80
440	440	Shell-Thin	457	siloh	LinStatic	194.24	47.35	48.75
441	441	Shell-Thin	457	siloh	LinStatic	194.38	47.12	-48.26
442	442	Shell-Thin	458	siloh	LinStatic	133.73	51.08	-97.61
443	443	Shell-Thin	459	siloh	LinStatic	34.89	45.61	-116.51
444	444	Shell-Thin	461	siloh	LinStatic	-43.54	10.76	-74.97
445	445	Shell-Thin	462	siloh	LinStatic	-52.24	71.23	51.27
446	446	Shell-Thin	463	siloh	LinStatic	16.04	75.47	118.36
447	447	Shell-Thin	464	siloh	LinStatic	122.99	46.51	138.36
448	448	Shell-Thin	464	siloh	LinStatic	205.03	-18.93	63.20