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The study on The Spatial Analysis of a Large Underground Project

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Abstract: This Study is about the spatial stress Analysis of a large Underground Civil Air Defence Projects in Guangdong Province. Aiming at The Problem of Plane Stress Models, Spatial calculation Models Are Built and the Results compared to those of Plane Stress Calculation Models Revealing How Internal Force of the Spatial Structure Models Change in Different Conditions

Keywords: A Large Underground Projects, Plane Stress, Spatial stress

I. Introduction :

There Are Many simplified calculation method To Deal with the Underground Civil Defence with Concrete Slab-Column Structure, Such as Direct Design Method, Equivalent Frame Method, Plastic Analysis Method, The Finite Elements analysis method And So on. But In Practical Projects, Apart From the Safety of Structure the Project's Economical Benefit Should be taken into Consideration in the Traditional Design Process, The Designer Used Simplify This Zonal Underground Spatial Structure into a Plane at The Structure's Cross Section and Solve the Problem by Using Plane Frame Model.

Under Some Particular Condition, This simplified Plane Model Could Gain Access to the Approximate Solution of Stress. But The Stress states simplified of calculating Method Differ from That in Practical Projects, So That the Practical Stress states Can Not Be Reflected Really. There by Analysing and Comparing to the Three-dimensional Model Related To practical Structure, Study the Force Characteristics Of spatial Structure Modal by Changing the Conditions, Some Conclusions are made.

II. Structure Forces Of Different Mode

2.1 General Information of the Project

The Project is located in a certain area In Guangdong. It is a Large Single Building Type Civil Air Defence Project for Public. Using Frame Structure With beamless Floor Slab System, it is Typical Zonal Structure Which Is Long And Narrow, With Two Layer Underground 1816 Meter In Length 112 meter In Width. The Roof Covering Soil Depth Is 3 Meter. The Natural Unit Weight 20KN/m3 And Underground Is Located at 5 Meters Underground. The Selection Drawing Of Main Structure Is Show in Fig 1

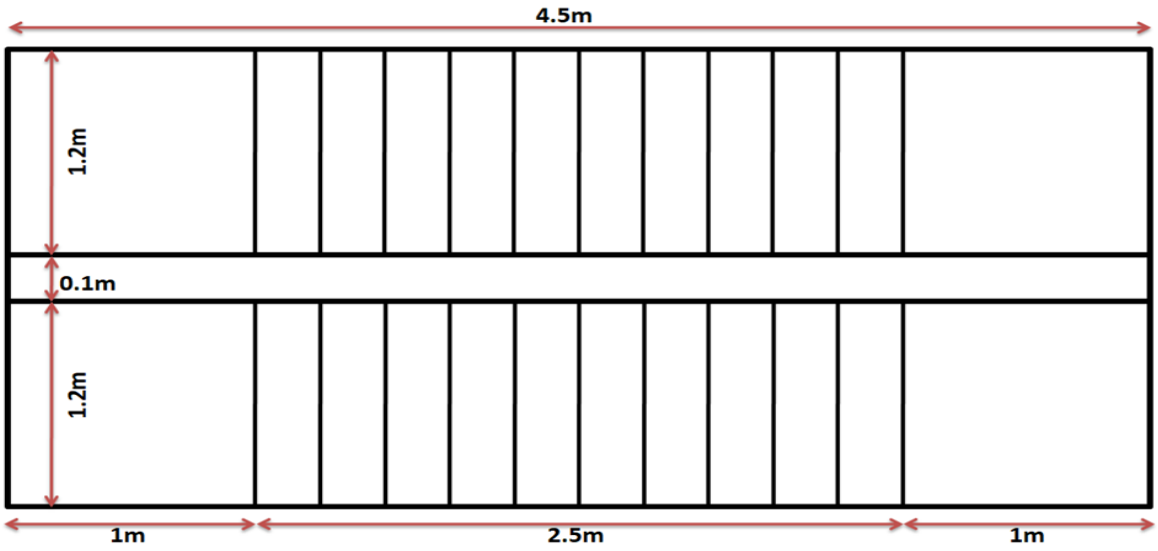


Fig 2.1 Sectional Drawing of Main Structure

The Primary Design For The Structure As The Thickness Of The Roof Is as 600mm, The Bottom Slab As 600mm And The Floor Of Middle Layer As 400mm The Outside Wall Thickness Of a 2nd Underground Is as 650mm and The 1st Underground is as 600mm The section Size Of Column Is as 800mm*800mm And The Column Space is 8m Long the Width 9m along the Length Due to The Protection Requirement Expansion Reinforcing band Will be Applied In The Projects instead Of post-pouring Strip And Expansion Joint.

III. Simplified Plane Model

According To The Rigidity Equivalence Method, Column is Equivalent To Continuous wall, Whose Thickness Is as 360mm. Taking One meter along The Length As The Plane Frame For Calculation, The Roof Bears The Load Of Civil Defence And Soil Upper, The Sidewall bears The Civil Defence Load And The Lateral Pressure Of Water And Soil, The Slab Of Middle Layer Bears The Load Of Crow And Fire Engine. The Behaviour of Bottom Plate and Soil Is Simulated BT Reaction Force and Slab Are Simulated By beam-Column element. The Model Is Shown In Fig3.1

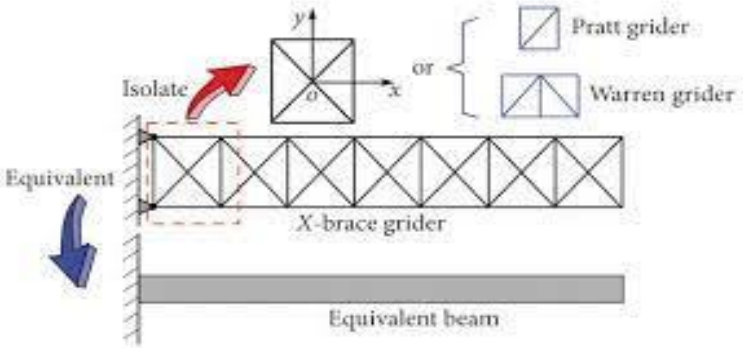
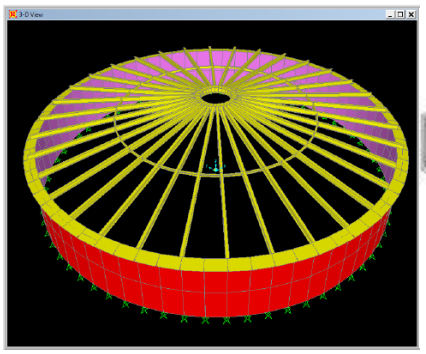
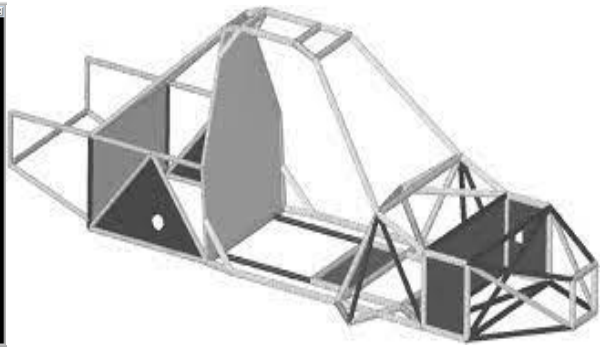


Fig 3. 1 The Model of Equivalent Load-model Of Plane Frame

IV. Spatial Calculation Model

In The Spatial Calculation Model, The Roof, The Slab of Middle Layer, The Bottom Slab and the outside Wall in the Structure are all simulated by Shell Elements, While the Column Is Simulated by Spatial by Beam and Column Elements, The Load on the Structure Are Column Elements.





4.1 The Model of Spatial Frame **4.2 the Load-Model of Spatial Frame**

V. Advanced Materials Research Volumes 446-449

5.1 Contradistinctive Analysis of the Simplified Plane Mode and the Spatial Model

In Order To Compare And Analyse The Calculation Results Between The Plan Mode And Spatial Model, The Load Combination Under The War-Period Case Had Been Considered For Calculation (1.2*Permanent Load + 1.0*Civil Air-Defence Load)

- The Calculating Result Of The Plane Are About 1.5Time Greater Than Those Of The Spatial Model, And The Results Of Roof Are Much More Outstanding.
- In the Simplified Plane Model, The Moment at Cross Point of the Slab & Column Is equivalent To That At He Crossing Point Of Wall and Slab And Its Valve Actually is The One OF the Moments at the Slab On The Column But In The Spatial Model, It can Be Realized That The Moment There Increase Rapidly. It is found that The Moments is Several Time Greater Than That of the Simplified Plane Mode and Stress Concentration Appear.
- The Ratio Of A/B Show The Change Of The Moments Between Plane Model And The Spatial Model. IT can be Realized That It Doesn't Change at the Slab of Middle Layer, Change A little At the Bottom Plate and Change Obviously at The Roof. The Roof IS Located At 3.0m Underground And Bottom Plate Located At 14.5m Underground, So The Civil Defence Load Have greater Effects On The Roof, Whose Internal Force Valve Obviously Changed

5.2 The Change Law of the Spatial Structure under Different Factors

Underground Structure Differs from Upper Structure As it's Surrounded By Soil, With Complicated Force Condition That The Related To Many Factors. Such as, Column Space, Column Gap, Boundary Condition, Elastic-Plastic Calculation And Working State And So On, Are The Column Factors That Affect Structural Internal Force. Expect Peacetime Case the Other Factors Are Assume the Same When Discussing a Certain one's Effect on Structure.

5.3 Column Spatial Effect on Structural Internal Force

Under The Situation Of Determined Column Space Along The Width, When Column Spaces Are Different Along The Length, In Simplified Plane Model, The Change Of The Column Space In Along The Width Can Be Taken Into Consideration, But The Column Spacing Along The Length Can Not. Serious Consideration Should Be Made When Selecting the Column Space for a Large Spatial Structure and Also, Frequent Modification Is Needed As it's Different to Determine At Once. 5 Conditions With Different Column Space Along The Length Will Be Discussed Below, Which Are 5M,7M,8M,9M And 11M. To Explain the Problem Conveniently the Set the Ratio of Vertical and Lateral Column Distance In The Following

5.1 Table of Calculation

Research method	Construction Management	Transportation	Structural	Other branches
Data Mining	2	3	3	5
Artificial Neural Networks	0	2	6	3
Case-Based Reasoning	5	0	0	0
Analytic Hierarchy Process	3	2	0	10
Analytic Network Process	2	0	0	0
System Dynamics	4	3	2	0
Agent-Based Modeling	1	5	0	1
Bayesian Belief Networks	3	1	0	1
Cluster Analysis	4	0	1	3
Decision Trees	3	3	2	0
Game Theory	3	3	0	0
Multi Agent Systems	2	7	0	2
Monte Carlo Simulation	0	3	2	2
Meta-Analysis	0	5	0	0
Quality Function Deployment	3	0	0	1
Simulated Annealing	0	0	5	1
Support Vector Machines	3	2	0	2

5.5 Some Results Can Be Taken Out From Whose On the Table Above:-

- Distribution Coefficients Of Moment Of Slab Strip Have Nothing To Do With The Valve Of Load. Except A Few Distribution Coefficients, Most Are Approximate Whose Of Beamless Floor Slab Used In Column Building. But There Is Difference Between The Distribution Coefficients Of Moments At End-Column And Negative Moments At Bearing Section In Civil Engineering. Here The Distribution Coefficients Of Negative Moments at The Bearing Section (mild Span) In Civil Engineering Is 0.75 At Slab Strip on Column, 0.25 At Mild-Span Slab Strip While The Distribution Coefficients Of Moments At End-Column Is 0.85 At s Slab Strip 0.15 At Mid-Span Strip
- The Change Of A Ratio Of Column Span Have An Effects On The Internal Force Slab When Column Space Along The Length Increases. The Moments Of Well-End Also Increases It Is Obvious And The Curve Is Smooth. The Moments of Slab Strip On Column of Side Span Change Greatly. With The increase Of The Ratio Of Column Space When Negative Moments Appears At Slab Strip On Column, With The Growth Of Column Space, The Negative Moments Of End-wall Expand To The Slab Strib On Column.
- As For Oversize Underground Engineering, the Values of the Moments at Middle of Side Span and Mid-Span and Column-End Are Sensitive To the Value of Column Space.

VI. Conclusion

To Sum up, Plane Calculation and Space Calculation Are Both Available in The Design of Civil Air Defence Projects. In Oversize Structure, The Economic Benefits Are High When Using The Model Of Spatial Calculation And Spatial Model Tend To Be Conservative. The Both Have Their Own Characteristics.

The Calculation Of Plane Frame Can Not Meet The Deformation Compatibility Equation And Design Is Easier And The Error Is Small. Spatial Calculation Is Suitable For Large Civil Defence Structure And It's Even More Needed In Super-Large Scale Of Civil Air Defence Projects Which Is More Complicated To Handle.

During The Design Of This Oversize Civil Air Defence Projects, There Are Many Factors Affecting The Internal Force Distribution And The Structure Types Are Complicated And Varied. Also In The Code There Are No Clears Rule Abouts Those Matters So That Is Becomes Very Important To Determine The Column Space And Simulate The Models And Models And Boundary Conditions Of The Structure, Because Spatial Calculation Model Taken More Factors Into Accounts

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