A structural design and analysis project was initiated for five-story building incorporating advanced engineering methodologies. Comprehensive research was conducted on structural engineering principles addressing geometrical and safety aspects of building design. Structural materials including steel sections and composite slabs were systematically evaluated. A detailed architectural layout was developed with considerations for various loadings types. A 3- dimensional structural model was constructed using SAP2000 to simulate practical scenarios. Sophisticated modeling techniques were applied by assigning constraints and releasing moments for structural members. Diaphragms were distributed across floor levels to simulate rigid body motion under lateral loads. Structural analysis was performed through iterative design processes. Moment-resisting frames and braced configurations were modeled in different directional orientations. Structural members were selected and validated against design standards. Comprehensive validation was executed through stress capacity checks and deformation assessments ensuring structural integrity and performance optimization.

22.2 Objectives

The chief aim of project was to model & examine comprehensive structural system for a five story building with optimal safety and efficiency. Other objectives included:

To boost structural performance by integrating composite slab systems and moment resisting frames.

To upgrade load-bearing capabilities through strategic selection of structural members and connection designs.

22.3 Nature of Works

I guided the comprehensive structural engmeermg project for a five-story building design. I supervised the initial conceptualization and research phase focusing on critical structural engineering principles. I assisted in developing a robust architectural framework that integrated advanced design methodologies. I managed the selection of appropriate structural materials including steel sections and composite slab systems. I directed the technical modeling process using SAP2000 software to simulate complex structural scenarios. I oversaw the comprehensive analysis of load distributions. I coordinated the structural member selection process ensuring optimal performance and safety standards. I facilitated the validation of structural designs

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23 Personal Engineering Activities(PEAs) 23.1

I got the details of the fundamental concepts of engineering necessary for the project. Thus, I realized the importance of geometrical, functional & safety aspects of building design. I gained knowledge in design materials such as steel sections, composite slabs & floor finishes. I learnt the various classifications of walls and their functions in the support of loads and lateral forces. I looked at the types of loads that the structure would be subjected to. I realized the understanding of structural modeling and analysis procedures through SAP2000 to simulate the practical scenarios. I collected information on structural members such as beams, columns, and bracings properties and their behavior under various forces. I understood the principles of connection design in order to load transfer of beams, columns & bracings properly. I investigated further on the code provisions for the design of the slabs and floor system in composite construction. I acknowledged the feasibility of all these components to come with a secure and optimal structural system.

23.2

I selected the building configuration based on a five-story layout with overall 14.5m high including a basement and varying floor heights. I assigned a composite slab system consisting of I 00mm thick concrete M32, placed on steel sheets 0.6BMT category. I incorporated clay tiling with a 13mm thickness for floor finishing and applied a waterproof layer on the top slab. I chose to analyze wind loads using SAP2000, assigning a regional wind speed of 45m/s for Region A2 and considering terrain category 4. I determined a superimposed dead load of 2kPa for intermediate beams. I computed dead loads for reinforced concrete slabs as 2.95kN/m and for partition walls as 6.03kN/m for typical floors. I assigned live loads of 2kN/m2 on all floors as per AS I 170. I chose to model moment-restraining frames in X-direction and X-type frames in Y for lateral resistance. I opted to model and evaluate structural connections for beams, columns, bracings, & slabs to ensure stability. I chose load combinations for stability and strength checks, incorporating dead, live, and wind loads as specified by AS/NZS 1170 standards.

23.3

I then developed a 3D structural profile(figure2) of structure in SAP2000 to reflect the architectural layouts that was used for the analysis. I assigned constraints by tying translations of parts in all directions while permitting rotations of the parts to make simpler bases of the plate(figure3). I released moments(figure4) for beams in the Y-direction so as to consider the braces impacts. I distributed diaphragms across all the floors to simulate a rigid body motion for the lateral loads. I load the models with live loads of 2kN/m2 and dead loads(figure6), the two constituting of reinforced concrete slabs loads, which amounts to 2.95kN/m. I set diaphragms in all floors (figure7 & 8). I included the wind loads in both X & Y direction(tablel). I performed structural analysis and obtained deformation shapes under wind loads. I verified deformations aligned(figure9) with expected behaviors, with displacements directed along the applied wind load directions. I analyzed story drift values(table2) and confirmed they were within allowable limits with maximum drift being 3.834mm at the first floor. I validated the model by analyzing beams in X and Y directions(figure!0). I ensured bending moments and deflection shapes matched theoretical expectations. In Y-direction beam, I observed zero bending moments at nodes and maximum moments at mid-spans. I reviewed bending moment and shear force diagrams(figurel I) confirming all structural members passed the stress/capacity(figure12) ratio checks. I found maximum design ratio did not exceed I thereby validating the structural design.

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Figure 2: Illustrate displaying 3D

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Figure 3: Imposing restrains at joints

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Figure 4: Depict of moment release in connections

1" floor 2nd Floor yd floor

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4th Floor 5th Floor

Figure 5: Display of floor layouts

LL DL

Figure 6: Display of LL & DL

Table I: Assignment of loading due to wind

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Angle

(DeJUees)

Windward Cp

Leeward Cp

WindSpeed

(mis)

Terrain Cate1a?;orv

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windY

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windX2

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windX- 3

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windX-

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180

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Figure 7: Illustrate of diaphragm assignment I st floor

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Figure 8: Illustrate of diaphragm assignment 4th floor

Figure 9: Display of deformed model shape in X(left) & Y(right)

Table 2: Drift evaluation

Floor slab

Proiram generated Drift

value

Actual Storey Drift (Difference between Door

drifts)

Maximum storey drift h/500 (h

= height of storey) (From Clause 2.3.2 of AS3600-2018)

mm

Remarks

Basement

0

Safe

Ground

2.645

2.645

4.2

Safe

First

6.479

3.834

6.8

Safe

Second

9.068

2.589

6

Safe

Third

11.722

2.654

6

Safe

Fourth

13.456

1.734

6

Safe

Items

[DEAD 7

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Equivalent Loads. Free Body Dia!!ram (Concentrated forces in KN, Concentrated llomenls in KNl-m)

Dist Load (2-<fir)

1.38 KN/m

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Positive in -2 dtectioo

Shear V2

-2.753 KN

ato. m

Resultant Moment

Deflactioos

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Moment M3

0. KN-m

at 0. m

Deflection (2-<lir) 0.m

ato. m

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Figure I 0: Display of validation for Beam grid 2(C-D) in Y

Figure 11: Display of BM(left) & SF(right) evaluation

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Figure 12: Checking capacity of stress for members

23.4

I was able to design the structural members through iterations of the section before arriving at the final section to be used. I confirmed that analyzed and designed sections(figure I 3) were the same for all steel frames. I defined the most efficient columns, including 250UC72.9s for ground floor and I 50UC30.0s for the upper floors. I varied beams according to spans; I used 360UB50.7 for

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Assume size of the fillet weld as 6mm.

:. Thickness of weld= 0.707 x 6 = 4.46 mm

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Due to eccentricity of 'P\* ',

M\* = 17.68 x 0.041 =0.725 kNm

Moment of inertia, I= (2 x 4.24 x 1003) / 12 = 0.7067 x 106 mm4 At extremities of weld,

fy=My/I= (0.725 x 50 x 106)/(0.7067 x 103) = 51.3 N/mm2

Force per unit length of weld = 51.3 x 4.24 = 217.512 N/mm2

Vertically, Force per unit length = (I 7 .68 x 103/(100 x 2 welds) = 88.4 N/mm Resultant force= J (217.512)2 + (88.4)2 = 234.8 N/mm

Now, Strength of weld, q>Vw= q> x 0.6.fuw.tt.kr Here, let us consider general purpose weld.

q> =0.6 (Table 3.4)

fuw= 490 MPa (Assumed 49xx weld. Hence, for 49xx weld, table 10.4.4) tr =4.24 mm

:.q>Vw= 0.6 x 0.6 x 490 x 4.24 = 747.94 N/mm > Resultant force i.e., 234.8 N/mm.

Hence it is safe. So, provide 6mm fillet weld with l Ml2 TB, 8.8 grade and 100mm x 10mm 250 grade cleat plate on both side of the connection .

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Figure I 3: Evaluating designed steel frames

Table 3: Display of optimized sections

Member / Direction

Desi2ned section

Assigned section

Floor Level

Column

250UC72.9

250UC72.9

Ground

250UC72.9

250UC72.9

First

150UC30.0

150UC30.0

Second

150UC30.0

150UC30.0

Third

150UC30.0

150UC30.0

Fourth

Main beam / X -direction

360UB50.7

360UB50.7

Ground

360UB50.7

310UB40.4

First

250UB31.4

250UB31.4

Second

250UB31.4

250UB31.4

Third

250UB31.4

250UB25.7

Fourth

Secondary beam / Y -

direction

180UB22.2

180UB22.2

Ground

180UB22.2

180UB22.2

First

180UB22.2

180UB22.2

Second

180UB22.2

180UB22.2

Third

150UB14.0

150UB14.0

Fourth

Intermediate beam

180UB18.1

180UB18.1

All

Bracing

250PFC

150PFC

Ground

250PFC

250PFC

First

150PFC

150PFC

Second

150PFC

125PFC

Third

l00PFC

l00PFC

Fourth

U4kN/Jn

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Figure 14: Display of connection design for250UC79.2 & 180UB22.2

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Figure 15: Display of connection design for 150UC30.0 & 250UB3 l .4

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Figure 16: Depict of column base plate connection

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Figure 17: Illustrate of 250 PFC bracing connection

23.5

I designed a composite slab using steel beams and concrete slabs to achieve the required strength and economic efficiency. I selected 32MPa concrete for the slab, ensuring adequate strength for residential applications. I used steel beams graded 300MPa with universal profiles. I adopted I 50UB 14.0 for the fourth floor and I 80UB22.2 for other floors. I incorporated Bondek(r) sheets of steel with 0.60BMT thickness providing a yield strength of 550MPa. I evaluated the effective slab width as 950mm. I determined the composite slab's deflection, which totaled 7.34mm under

combined effects, staying within the permissible I imit of I 5.2mm. I determined beam stresses at 19.44MPa, well below the 270MPa threshold. I found the shear connector capacity per stud to be

88.SkN. I adopted eight shear connectors of I 9mm diameter spaced at 230mm. I concluded the project by verifying all structural parameters. I ensured compliance with AS 3600:2001 standards, confirming the composite slab's safety and serviceability. I noted design achieved the intended strength & cost-efficiency while meeting the deflection and stress criteria effectively.

2.4 Problem and Solution

One issue that I experienced was in evaluation of deflection limits when designing the composite slab. I considered the problem with my colleagues. I expressed my concerns on overloading permissible limits both under the sustained and transient loads. I also realized that the dimension of the slabs was not consistent in the model was the cause of the errors. I was confident that an improper distribution of load resulted from misaligned boundary conditions. I discussed with my supervisor to ensure my way of thinking. I was able to draw conclusions about why the deflection results varied. I was advised on how to enhance the boundary conditions and to apply proper loads. I redeployed the model based on the advice. I made the input parameters to be consistent. I constrained translations were by fixing all the axes whereas rotations were permitted & set joint restraints. I had to reduce the generality of the base plate designs in order to get equal load distribution. I re-evaluated the deflection & confirmed it met permissible limits resolving the issue efficiently.

2.5 Creative Works

I assigned several constraints of the joint that I made the translation in all direction fixed while letting the rotation occur. I provided modifications to the base plate designs to address matters concerning the transfer of uniform loads.

2.6 Project Management

I always convened the team to review and set objectives as well as to evaluate the progress being made by the team. I did meetings towards the generation of innovative strategies and solutions. I delegated duties among the team members, and made it a point that the timelines were well defined. I reported supervisor on progress made & I sustained two-way communication with the members of the team in order to solve any problems. I encouraged members of the team to keep

working on the project. I scheduled gatherings with our guide to make decisions on how to tack.le any issues on the project. I had to make sure all the team members were on tlhe same page as regards the project. I encouraged cooperation and deal with issues of conflict effectively. I kept the work atmosphere positive in order to create efficiency and unity in my team.

2.7 Codes

I set structural LL in design following AS1170:2002 & NZS 3404: 1997 for steel sections.

2.8 Summary

2.8.1

The structural design project for a five-storey building was successfully completed through systematic engineering approaches. Fundamental structural engineering concepts were initially investigated. Comprehensive review enabled understanding of geometrical design principles and safety aspects. A detailed architectural configuration was selected with specific dimensional parameters. Structural modeling was performed using SAP2000 software for comprehensive analysis. Wind load simulations and lateral force evaluations were conducted. Structural members were analyzed and designed with precision. Moment-restraining frames were modeled. Structural validation was achieved through detailed stress capacity checks. Composite slab systems were designed incorporating steel beams and reinforced concrete. Connection designs for beams columns and bracings were rigorously evaluated. Final designs were validated against Australian standards ensuring optimal structural performance and safety. To improve structural performance, the composite slab systems consisting of reinforced concrete and steel sheets were adopted. Resistance to loading was enhanced by selecting appropriate steel sections and proper connection details that were optimized using structural analysis and modeling.

2.8.2

I developed leadership roles since I managed to well coordinate the team. I honed interaction abilities via project gatherings. I also improved on time management through honoring deadlines. I gained motivational skills. I achieved to enhance my competencies in the course of the performance.