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The Effect of Columns End Twisting Due to Molds Movement on Column Capability to Carry the Applied Loads of Al - Masbah Telecom Center in Iraq

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Abstract— Concrete construction process faces a lot of problems seeking them continuously can raise the efficiency of construction process and concrete members. One of the major problems which occurred in concrete structure projects is the movement of the wood mold during construction, the concrete member may deform and case a deterioration of other surrounding structural members. This study investigates one of the critical problems in the building of Al-Masbah Telecom Center Company in Iraq. The twisting of the upper ends of the columns 25 mm was occurred while the lower end remains fixed, this rotation was achieved due to the movement of the wooden mold during construction process. This certain problem required re-analysis and extensive study to take a decision regarding the adequacy of column capability to carry applied load and redistribution of stresses in all structural members. The structural calculations revealed that there was no effect due to end twisting on column capability to carry the applied loads and structure stability. This study focuses on repairing one of a telecommunications concrete buildings in Baghdad (capital of Iraq); the damage in building was carried out due to twisting of columns as a result of movement in the mold during construction. This study includes an illustration of the damage causes and repairing methods. It is also includes a theoretical calculations of capacity of these columns after damage occurrence, and comparing the results with capacity of undamaged columns. This study also dealing with a reanalysis of the structure carrying capacity for applied loads.

Keywords— Twisting, column, mold, cover, and axial load.

1. Introduction

There is no doubt that the cracking of concrete building has become a noticeable phenomenon, and appeared defects of different types and forms ranging from simple cracks or cracks lead to partial or total collapse of the building [1]. Some of the reasons that lead to the emergence of structural defects as follow [2]:

A. Mistake in implementation.
B. Lake of supervision of implementation.
C. Deficiencies in the soil investigation.
D. Errors in the design.
E. Insufficient of structural details.

Molds shall be sufficiently safe for all structural elements during processing, reinforcing and casting during hardening and up to the final setting; the principals of industrial security shall be available to all workers, with the possibility of inspection and monitoring easily and safely. The formulation and installation shall take in to account the means of preventing the movement of molds, as well as taking in to account that the molds shall be firm and tight to prevent the collapse and leakage during casting and compacting. Molds should be prepared so that their movement does not affect the steel reinforcement or concrete during pouring [3]. Cracks or deformations in the concrete elements depend mainly on the time to be elapsed between the pouring of concrete and dismantling molds [4], temperature [5], span length [6], cement type [7], curing method [8] and load that will be applied to the member [9] and must ensure that the time of removing molds is sufficient to concrete for acquisition of strength provided by design requirements. Redistribution of stresses is not taken in to consideration in the design of buildings. So, when errors occur in the structural elements, the structure should be reanalyzed to match the new stress state.

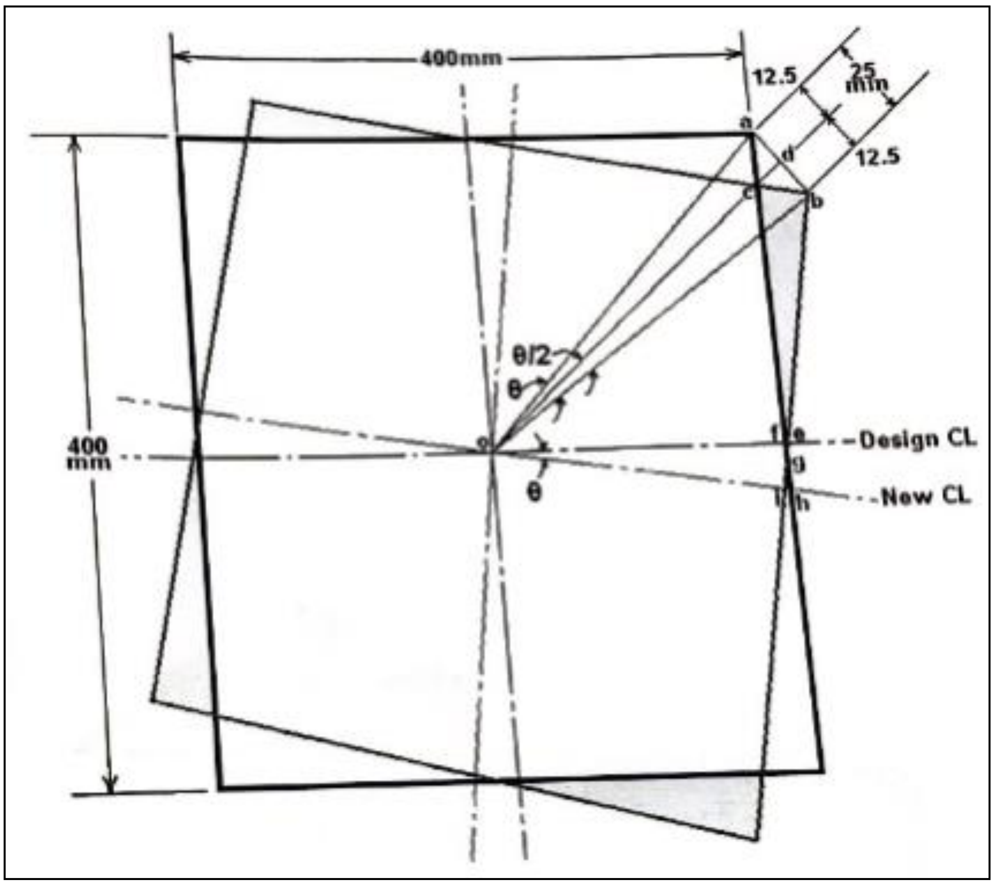
2. Necessary Requirements

For such cases and check the safety of the building and determine the amount of deviation from the specification, usually must checking three points as follows:

A. Aesthetics of the building.
B. Provide concrete cover and conform to specification.
C. Checking the structural analysis and recalculation of safety factor to carry the loads on the affected structural member, and ensure the adequacy of the structure.

3. Calculation of Deducted Areas

As shown in Fig. 1, the deformed shape is shown:



$oa = ob = \sqrt{200^2 + 200^2} = 282.8$mm.

$ad = db = 12.5$ mm

The angle $odb = 90°$

$od = \sqrt{ob^2 + db^2} = \sqrt{282.8^2 + 12.5^2} = 282.5$mm

$\sin\frac{\theta}{2} = \frac{db}{ob} = \frac{12.5}{282.8}$.

The angle cbd 180 – 90 – 45 – ɵ/2 = 42.465 º

db/cb= Cos(cbd).

12.5/cb = cos (42.465) ≫ cb = 16.95 mm

The angle foh = ɵ = 5.07 º

fh/of = tan ɵ

fh = 200 tan (5.07) = 17.75 mm

of/oh= cos (5.07) » oh = 200/cos〖 (5.07) 〗 = 200.785 mm

ih =oh = oi = 200.785 – 200 = 0.785 mm

Δihg≡Δgcb

ih/cb = ig/gb

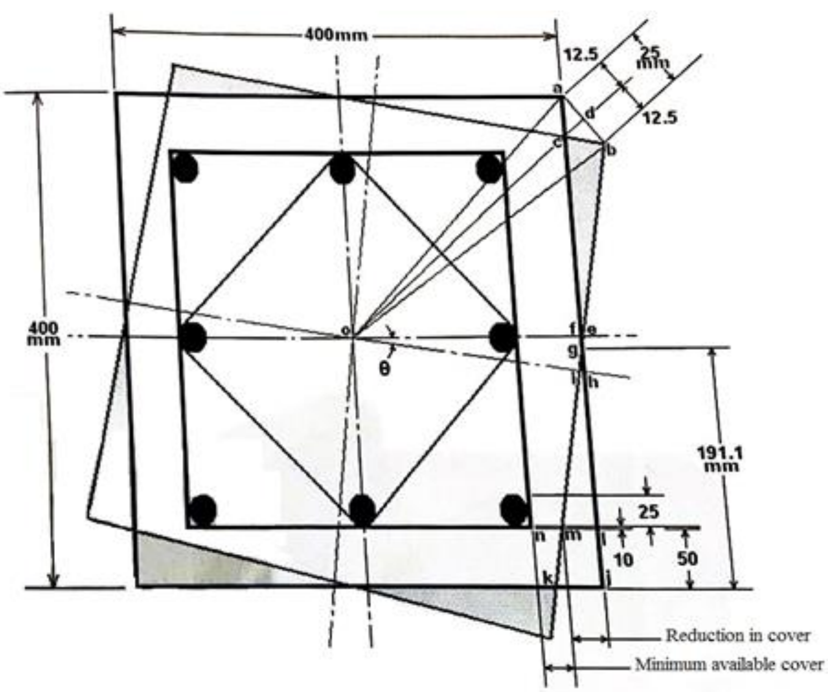
0.785/16.95 = ig/(200-ig) » ig = 8.852 mm.

bg = bi – ig = 200 – 8.852 = 191.1 mm.

Area of cbg = 1/2x bg x cb = 1/2x 191.1 x 16.95 = 1619 mm2.

Total deducted area = 4 x 1619 = 6478 mm2.

4. Calculating the Minimum Available Cover
As shown in Fig. 2, the deformed shape is shown:



gj = gb =191.1 mm, kj = cb = 16.95 mm
$\Delta gml \equiv \Delta gkj$
ml/kj = gl/gj = Reduction in cover = ml = ((191.1-50) *16.95)/191.1 = 12.5 mm.
Minimum available cover = jk – ml = 50-12.5 =37.5 mm.

5. Calculation of Structural Load

A. Applied Loading Dead load:

• Roof slab + roofing = 0.3 x 2.5 = 0.75 T/m2
• Second floor slab + tiles = 0.3 x 2.5 = 0.75 T/m2
• Framing beams = 2(0.4 x 0.5 x 9.4 x 2.5) = 9.4 T
• Column above = 0.4 x 0.4 x 4.5 x 2.5 = 1.8 + Finishing = 2 T

Live load:

• Roof load = 0.2 T/m2
• Second floor = 0.3 T/m2

Total Applied Factored Loading = 1.4 x [5.2 x 4.2 x (0.75 + 0.75) 9.4 + 2] + 1.7 x (0.5 x 5.2 x 4.2) = 80 T.

B. Ultimate Axial Load (without Twisting)

400x400 concrete column reinforced with 8#25 steel bars can sustain the following axial load (Pn):
Pn= 0.7[0.85 x f'c x Ac +Ast fy]
Minimum ultimate compressive strength of concrete according to the attached testing report No. 10715 dated 23/8/2010 is :fcu= 30.1 MPa
Ultimate compressive cylindrical strength of concrete
f'c = 0.85 x fcu = 25.6 MPa
Design cross sectional area Ac = 400 x 400 = 160000 mm2
Total area of main steel reinforcement Ast = 8 x 500 = 4000 mm2
Yield strength of steel fy = 414 MPa
Pn = 0.7[0.85 x 25.6 x 160000 + 4000 x 414] = 3596320 N = 3596 kN = 360 T
So, the column able to carry 4.5 times the applied load without twisting.

C. The Effect of Twisting

The effect of 25mm twisting will reduce the effective cross-sectional area of the concrete by the sum of the area of the four triangle which is equal to (6478mm2) as shown Fig.1, so the ultimate axial load (the actual twisted column) can sustain is:
Pn = 0.7[0.85 x 25.6 x (160000 – 6478) + 1656000] = 3497647 N = 3497 kN = 350 T
So, the column able to carry 4.25 times the applied load with twisting

D. The Effect of Aging of Concrete

Due to aging of concrete its strength will increase as shown in Table 1:

Characteristic strength MPa	Age at loading					
	7 days	28 days	2 months	3 months	6 months	1 year
20	0.68	1.00	1.10	1.15	1.20	1.25
25	0.66	1.00	1.10	1.16	1.20	1.24
30	0.67	1.00	1.10	1.17	1.20	1.23
40	0.70	1.00	1.10	1.14	1.19	1.25
50	0.72	1.00	1.10	1.11	1.15	1.20

This means that the ultimate strength of concrete after 1 year of casting will be 1.25 time its strength after 28 days. In other words, the concrete cube strength of 30.1 MPa will be 31.1 x 1.25 = 37.6 MPa. Therefore, the concrete cylindrical strength will be:

f'c = 0.85 x F cu = 31.96 MPa

Pn = 0.7[0.85 x 31.96 x (160000 – 6478) + 1656000] = 405120 N = 4051 kN = 405 T

So, the column able to carry 5 times the applied load after I year with twisting.

6. Conclusion

The structural calculations of the damaged column were carried out according to ACI318-11, the calculations showed that the column is structurally safe, as the damage caused by the defect in the mold does not affect the structural behavior of the column.

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