

Comparative Assessment of Reinforced Concrete Slab Systems for Office Buildings in Kuwait



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Table S1. Long-term deflection serviceability comparison for all optimized slab systems.

Design	Span (m)	Total vertical long-term deflection (mm)	Relative long-term deflection to slab edges (mm)	Limit, $L/240$ (mm)	Relative deflection utilization	Status
Design 1	6	33.3	17.4	25.0	69.6%	OK
Design 1	9	68.0	34.6	37.5	92.3%	OK
Design 2	6	31.8	17.2	25.0	68.8%	OK
Design 2	9	67.3	30.8	37.5	82.1%	OK
Design 3	6	31.4	18.8	25.0	75.2%	OK
Design 3	9	57.1	35.0	37.5	93.3%	OK
Design 4	6	27.6	15.5	25.0	62.0%	OK
Design 4	9	48.6	30.0	37.5	80.0%	OK
Design 5	6	35.8	17.6	25.0	70.4%	OK
Design 5	9	52.1	27.6	37.5	73.6%	OK
Design 6	6	28.8	14.4	25.0	57.6%	OK
Design 6	9	59.7	30.8	37.5	82.1%	OK

Note: The total vertical long-term deflection represents the total downward ETABS displacement, while the relative long-term deflection represents the slab panel deflection relative to its edge/support line. The relative deflection was compared with the $L/240$ limit because it reflects the slab's serviceability behavior between supports. A utilization value below 100% indicates that the slab satisfies the adopted deflection limit.

Table S2. Punching shear, story drift, and story stiffness comparison for all slab systems.

Design	Span (m)	ETABS drift (mm)	Amplified drift, $C_d I_e = 4.0$	Drift limit, $0.020h_{sx}^*$ (mm)	Drift utilization n*	Story stiffness (kN/m)	Punching/shear result	Punching/shear status
Design 1	6	1.72	6.88	60.0	11.5%	4,958,224	N/A; beam-supported system	Beam shear/flexure governs
Design 1	9	1.96	7.84	60.0	13.1%	5,176,682	N/A; beam-supported system	Beam shear/flexure governs
Design 2	6	1.74	6.96	60.0	11.6%	4,958,500	N/A; beam-supported system	Beam shear/flexure governs
Design 2	9	1.95	7.80	60.0	13.0%	5,166,095	N/A; beam-supported system	Beam shear/flexure governs
Design 3	6	1.30	5.20	60.0	8.7%	4,965,435	0.767	OK
Design 3	9	1.92	7.68	60.0	12.8%	5,225,595	0.954	OK
Design 4	6	1.35	5.40	60.0	9.0%	5,026,785	0.849	OK
Design 4	9	2.01	8.04	60.0	13.4%	5,350,613	1.12; shear studs 12×3 @ 75 mm	Additional punching shear reinforcement required
Design 5	6	1.27	5.08	60.0	8.5%	4,920,800	Edge = 0.835; Inner = 0.824	OK
Design 5	9	1.87	7.48	60.0	12.5%	5,186,063	Edge = 0.982; Inner = 0.813	OK
Design 6	6	1.34	5.36	60.0	8.9%	5,012,067	Edge = 0.888; Inner = 0.848	OK
Design 6	9	2.00	8.00	60.0	13.3%	5,278,617	1.21; shear studs 12×3 @ 75 mm	Additional punching shear reinforcement required

* Drift limit and utilization are shown using a conservative assumed story height of $h_{sx} = 3.0$ meters. If the final ETABS model uses a different story height, the limit should be updated as $0.020h_{sx}$.

N/A = not applicable for slab punching shear because beams frame into the columns and transfer slab loads through beam action.

Table S3. Serviceability indicators and practical advantages of each slab system.

Design	Slab system	Main serviceability observations	Benefits/advantages	Key caution
Design 1	One-way solid slab	Deflection and drift checks are satisfactory. Punching shear is not applicable where beams frame into columns.	Simple, conventional, easy to design and construct; beam support reduces punching shear concern at columns.	Less efficient for longer spans because beam/slab demand increases and architectural flexibility may be reduced by beams.
Design 2	Two-way solid slab with beams	Deflection and drift checks are satisfactory. Punching shear is not governing because load is transferred through beams.	Two-way load distribution improves structural redundancy; beams provide clear load paths and reduce the risk of slab-column punching.	More formwork and deeper beams may increase construction complexity and affect ceiling clearance.
Design 3	Flat slab with edge beams and drop panels	Deflection is satisfactory, but the 9-meter case has high utilization, 93.3%. Punching shear ratios remain below 1.0.	Drop panels improve punching shear resistance, while edge beams improve perimeter stiffness. Good secondary option where additional stiffness is preferred.	A 9-meter deflection is close to the serviceability limit, so final detailing should carefully account for deflection and cracking.
Design 4	Flat slab with edge beams	Strong lateral stiffness and good deflection performance. Highest story stiffness at both spans.	Edge beams improve stiffness and reduce drift sensitivity; suitable where stiffness is prioritized.	At 9 meters, the punching shear ratio exceeds 1.0, requiring shear studs and adding detailing and construction complexity.
Design 5	Flat slab with drop panels	Deflection and drift checks are satisfactory. Punching shear is acceptable at both spans, although the 9-meter edge ratio is close to 1.0.	Best overall balance in the main MCDM results; drop panels improve punching capacity while avoiding continuous beam volume. Provides good economy, low weight, and low lateral movement.	The 9-meter edge-punching ratio of 0.982 is close to the limit, so the final detailing should carefully verify the edge-column punching.
Design 6	Flat plate	Deflection and drift checks are satisfactory. Punching shear is acceptable at 6 meters but exceeds 1.0 at 9 meters.	Clean soffit, simple ceiling coordination, and architectural flexibility because beams and drop panels are avoided.	Punching shear becomes critical at 9 meters and requires shear studs; beam-free systems need careful punching and vibration checks for longer spans.

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