SUSPENDED FLOOR SYSTEMS

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Suspended Concrete Floor Systems

KWIKSLAB

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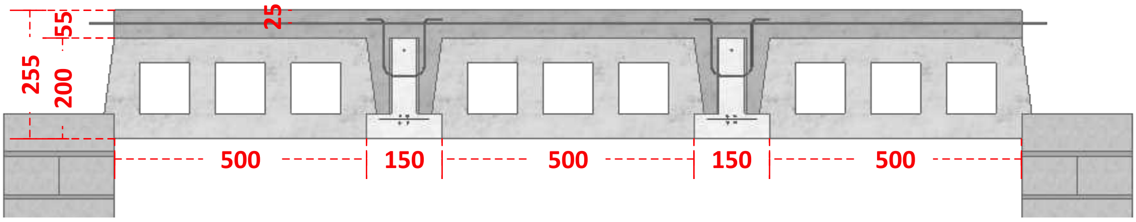
Design

The Kwikslab precast floor system consists of three components, namely the precast ribs and blocks as well as an optional concrete topping which is cast in situ after placement of the precast members.

KWIKSLAB SECTIONAL ELEVATION



SIDE ELEVATION
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The purpose of prestressing is to reduce deflection and control the formation of cracks within concrete members. For this reason, prestressed members are designed to satisfy serviceability requirements and are then checked for ultimate limit state.

If an engineer is consulted for the design of the floor slab the following capacities may be used:

Ultimate Limit State Capacity	Capacity per rib	Slab Capacity
Sagging Moment	17.56 kNm/rib	29.3 kNm/m
Hogging Moment	9.7 kNm/rib	16.2 kNm/m
Shear force at support	32 kN/rib	53 kN/m

If an engineer is not consulted for the design of the floor slab the following must be adhered to:

Ultimate Limit State Capacity	Capacity (kPa)	Capacity (kg/m^2)
Applied pressure (up to 6m span)	1.5 kPa	150 kg/m^2

Assumptions

The following physical properties were used to perform the design check:

- 28-day concrete cube strength = 60MPa
- Prestressed wire ultimate strength = 1570MPa
- Rib spacing is 600mm as per block width

Assumptions:

- 55mm Concrete topping is included in design as per drawing.
- Grade 1570 triple indent low relaxation PC wire was used as prestress reinforcement.
- 100% bond between the precast members and the in situ casted slab topping.
- Beam is a Class 3 (partially) prestressed beam.
- The values presented above allow for the self-weight of the kwikslab system

Loading

Due to the wide variety of possible loading scenarios which the system might be exposed to, the engineer responsible for the design of the structure which makes use of the product, will be required to calculate the expected loading to ensure they do not exceed the products' capabilities.

Table A presents the expected loading which the Kwikslab might be exposed to in accordance with SANS 10160-2:2011

TABLE A: EXPECTED LOADING

LOAD	VALUE
Cast in situ topping	1.7kPa
Finishes	0.5kPa
Imposed Load (All rooms in a dwelling)	1.5kPa (evenly distributed) or 1.5kN (point load)
Imposed Load (Balconies)	4kPa (evenly distributed) or 3kN (point load)
Imposed Load (Offices)	2.5kPa (evenly distributed) or 4.5kN (point load)

Serviceability Limit State (SLS)

Due to the intended purpose of prestressing being a tool for crack and deflection control, the Serviceability Limit State is often the governing design criteria which needs to be satisfied. This section was done in accordance with SABS 0100-1:2000.

Due to the assumption that the beams are class 3 prestressed beams, the criteria for design is that crack widths may not exceed 0.1mm for harsh environmental conditions and 0.2mm for other conditions.

The equation which governs this design criteria is:

$$w = 0.0125 \left[ft \Big/ \frac{100\,\Sigma As}{bh} \right]$$

Table B presents the parameters used in this calculation as well as the resulting Maximum permissible tension stress allowed in the outer most concrete fibre.

TABLE B: SLS DESIGN PARAMETERS

PARAMETER	SYMBOL	VALUE	UNIT
Crack Width	w	0.2	mm
Area of Tension Steel	As	78.5	mm^2
Width of section in Tension Zone	b	60	mm
Height of the section	h	255	mm
Maximum Allowable Tensile stress	*ft*	8.2	MPa

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Serviceability Limit State (SLS)

The maximum allowable tensile stress calculated in the table above consists of a prestress due to the prestressed tendons, and a bending stress which is caused as a result of loading of the beam.

The maximum allowable sagging bending moment which the beam is able to resist is then able to be calculated by using the equations below:

$$ft = \sigma 1 + \sigma 2 \qquad \sigma 1 = \frac{P}{A} + \frac{P.e}{Z} \qquad \sigma 2 = \frac{M.y}{I}$$

Table C presents the parameters used in the calculation of the allowable bending stress due to loading on the beam.

TABLE C: SLS DESIGN PARAMETERS

PARAMETER	SYMBOL	VALUE	UNIT
Maximum Allowable Tensile Stress	ft	8.2	MPa
Initial Prestress Force	Pi	737	kN
Long Term Prestress Force	P	589	kN
Eccentricity	e	74.2	mm
Section Area	A	19 800	mm^2
Prestress at outermost Fibre	$\sigma 1$	6.76	MPa
Moment of Inertia around Neutral Axis	I	120 377 472	mm^4
Depth to Neutral Axis	y	104	mm
Allowable Bending Stress	$\sigma 2$	14.99	MPa

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Ultimate Limit State (ULS)

The ultimate limit state conditions were determined in accordance with SABS 10100-1:2000. The ULS capacities were calculated using the equation:

$$M_R = f_{pb} A_{ps} (d - d_n)$$

The physical properties used to analyse the Kwikslab system are presented in Table D.

TABLE D: ULS DESIGN PARAMETERS

DESIGN PROPERTY	SYMBOL	VALUE	UNIT
Ultimate tensile stress of PC wire	$f_{u,p}$	1570	MPa
Material safety factor	Y_m	1.15	
High tensile reinforcement yield strength	$f_{u,r}$	450	MPa
Effective depth	d	225	mm
Depth to centre of compression zone	d_n	37.3	mm
Prestress	P	937	MPa

Note that the ULS capacities for the complete system assume that there is 100% bond between the precast members and the cast in situ concrete topping. A 100% bond between the precast and cast in situ members will cause the suspended floor to behave as a single unit and thus is analysed as such.

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Design Charts

The capacity of the member is dependant on the span and spacing of the beams. The following charts present the capacities of both the serviceability and Ultimate Limit States of the current Kwikslab design. **(Please continue reading on page 7 for important notes).**

TABLE E: SERVICEABILITY LIMIT STATE DESIGN CAPACITY

SLS CAPACITY TABLE (kPa)												
SPAN (m)	BEAM SPACING (mm)											
	100	200	300	400	500	600	650	700	800	900	1000	1100
1.0	701.1	349.1	231.8	173.1	137.9	114.4	105.4	97.7	85.1	75.3	67.5	61.1
1.5	310.0	153.6	101.5	75.3	59.7	49.3	45.3	41.8	36.2	31.9	28.4	25.6
2.0	173.1	85.1	55.8	41.1	32.3	26.4	24.2	22.3	19.1	16.7	14.7	13.1
2.5	109.8	53.4	34.7	25.3	19.6	15.9	14.4	13.2	11.2	9.6	8.4	7.4
3.0	75.3	36.2	23.2	16.7	12.8	10.2	9.1	8.3	6.9	5.8	4.9	4.2
3.5	54.6	25.8	16.3	11.5	8.6	6.7	6.0	5.3	4.3	3.5	2.9	2.3
4.0	41.1	19.1	11.8	8.1	5.9	4.4	3.9	3.4	2.6	2.0	1.5	1.1
4.5	31.9	14.5	8.7	5.8	4.1	2.9	2.5	2.1	1.5	-	-	-
5.0	25.3	11.2	6.5	4.2	2.8	1.8	1.4	1.1	-	-	-	-
5.5	20.4	8.8	4.9	2.9	1.8	-	-	-	-	-	-	-
6.0	16.7	6.9	3.6	2.0	1.0	-	-	-	-	-	-	-

TABLE F: SERVICEABILITY LIMIT STATE DESIGN CAPACITY

SLS CAPACITY TABLE (kPa)												
SPAN (m)	BEAM SPACING (mm)											
	100	200	300	400	500	600	650	700	800	900	1000	1100
1.0	1603	799.7	531.9	398.1	317.8	263.8	243.7	226.0	197.3	175.0	157.1	142.5
1.5	707.2	351.9	233.4	174.2	138.7	115.0	105.9	85.4	85.4	75.5	67.6	61.1
2.0	393.8	195.2	129.0	95.8	76.0	62.7	57.7	46.2	46.2	40.7	36.3	32.6
2.5	248.7	122.6	80.6	59.6	47.0	38.6	35.3	28.1	28.1	24.6	21.8	19.5
3.0	169.9	83.2	54.3	39.6	31.2	25.4	23.2	18.2	18.2	15.8	13.9	12.3
3.5	122.4	59.5	38.5	28.0	21.7	17.4	15.9	12.3	12.3	10.5	9.1	8.0
4.0	91.5	44.0	28.2	20.3	15.5	12.4	11.1	8.4	8.4	7.1	6.0	5.2
4.5	70.4	33.5	21.1	15.0	11.3	8.8	7.9	5.8	5.8	4.7	3.9	3.2
5.0	55.3	25.9	16.1	11.2	8.3	6.3	5.6	3.9	3.9	3.1	2.4	1.9
5.5	44.1	20.3	12.4	8.4	6.0	4.5	3.8	2.5	2.5	1.8	1.3	-
6.0	35.5	16.0	9.5	6.3	4.3	3.0	2.5	1.4	1.4	-	-	-

STRUCTURAL DETAILS

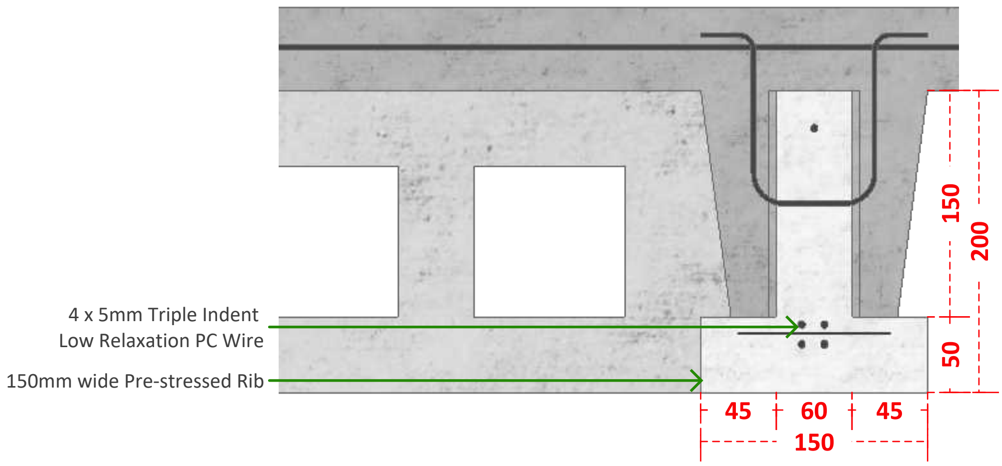
Design Charts

* The above capacity tables take into account the self-weight of the blocks and 55mm concrete topping.

** Only a material safety factor has been included in the calculation of the capacity charts due to the uncertainty of possible loading variations. Load safety factors should be applied by the engineer when designing the structure in which the Kwikslab is used.

Design alterations can be performed to improve on the capabilities of the current design and these should be discussed with the engineer.

Typical Pre-stressed Rib Section



SIDE ELEVATION
SCALE 1:5

3D Example