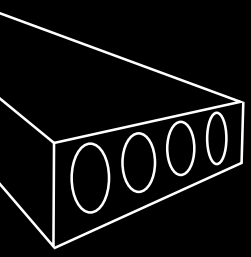
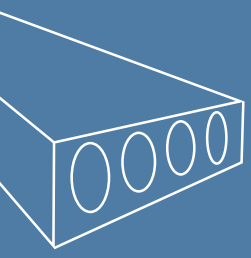
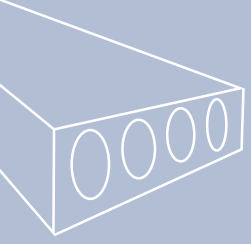






PRESTRESSED HOLLOW-CORE SLABS ON LOAD BEARING MASONRY

The most economical solution for medium rise structures July 2009

Quality, strength, speed.

Proven by cost comparison studies.

CMA CONCRETE MANUFACTURERS ASSOCIATION

Quality cast in concrete

1. INTRODUCTION

These cost comparisons set out the result of a study which examined prestressed hollow-core slabs on load bearing masonry and in-situ concrete framed structures with infill masonry.

Case Study A: *A seven storey residential structure in Pretoria.*
One in-situ level with six storeys of load bearing masonry above.

Case Study B: *A five storey load bearing masonry residential structure in Johannesburg.*

2. DESIGN PARAMETERS AND ASSUMPTIONS

The common features of the structural design of both buildings are as follows:

- *They are designed for a specified imposed load of 1.5kN/m^2 plus 1.5kN/m^2 for finishes.*
- *Deflection limits are taken as defined in SANS 10100 to a maximum of span/300*
- *Standard weight concrete is used for both structures*
- *Bearing limits for the hollow-core slabs are taken as defined in SANS 10100 section 6.5.4.4, with appropriate allowance being made for reduced levels of prestress (and hence shear resistance) within the transmission length of prestress units.*
- *Continuity — 9.53mm strands at 1200mm long were introduced over supports.*
- *Fire resistance properties for hollow-core slabs for residential buildings over 2 storeys are taken as 25mm minimum thickness under cores in hollow-core slabs, which provide a one hour fire rating.*
- *Durability — The high strength (up to 60MPa and more), high quality concrete achieves a guaranteed durable product which complies with the requirements of SANS 10100:1.*
- *Accidental damage and progressive collapse — SANS 10164 Part 1 (4) gives guidance on design aspects relating to accidental damage for category 2 (all buildings of five storeys and more), to limit the extent of accidental damage to the immediate vicinity, while maintaining structural integrity of the remainder of the building.*

3. THE PROFESSIONAL TEAM

- *The CMA appointed the services of leading professionals in the industry to audit and examine the cost savings presented by the contractors and professionals responsible for the two projects.*
- *The reason for doing this is to present the building industry with an unbiased report.*
- *The auditing was done by:*

Mark Raubenheimer of Bathuleng, Wallace, Raubenheimer Registered Quantity Surveyors or BWR Quantity Surveyors.

Design verification: Case Study A
Don Theron (DG Consulting Engineers)

Design verification: Case Study B
Simon Knutton of Knutton Consulting

The Manufacturer
Echo Prestress (Pty) Ltd — Manufacturer of the hollow-core flooring

4. CASE STUDY A - PRETORIA

30.76% saving

Details of the quality and strength of bricks and mortar specified:

- *The first level was cast in-situ.*
- *The six floors above constructed in load bearing masonry*
- *14MPa bricks specified for levels two and three*
- *10MPa bricks specified for the upper levels*
- *Mortar strength: Class 1 throughout*

Elemental construction cost per m² gross floor area for structural options

July 2009

Trade	Cast in-situ slab method of construction cost	Rate/m²	P.C. Hollow core slab method of construction cost	Rate/m²	Variance	Percentage variance	Rate/m² variance
1. Concrete, formwork and reinforcement	1,124,625.20	564.44	851,119.86	427.17	(273,505.34)	-24.32%	(132.27)
2. Masonry	0.00	0.00	0.00	0.00	0.00	0.00%	0.00
3. Metal work	0.00	0.00	125,615.72	63.05	125,615.72	0.00%	63.05
4. Plastering and screeding	365,155.10	178.75	192,298.66	96.51	(163,856.35)	-46.01%	(82.24)
5. Painting to slab soffits and steel support	69,735.89	35.00	82,666.92	41.49	12,931.03	18.54%	6.49
Sub Total cost (in R)	**1,550,516.10**	**778.19**	**1,251,701.16**	**628.22**	**(298,814.94)**	**-19.27%**	**(149.97)**
Construction period (weeks)	18		12				
Est. savings in preliminary related costs for portion of construction under review	257,142.86	129.06	0.00	0.00	(257,142.86)	0.00	(129.06)
Total cost (in R)	**1,807,658.95**	**907.25**	**1,251,701.16**	**628.22**	**(555,957.80)**	**-30.76%**	**(279.03)**

5. CASE STUDY B - JOHANNESBURG

23.79% saving

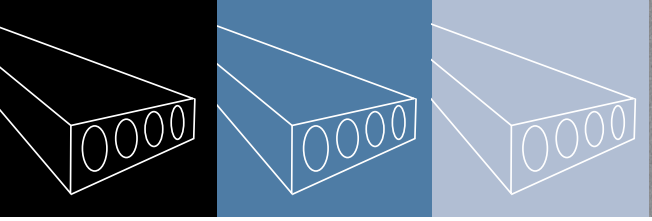
Details of the quality and strength of bricks and mortar specified.

- *14MPa bricks specified for ground and first floor.*
- *10MPa bricks specified for the upper levels.*
- *English bond applied throughout*
- *Mortar strength: Class 1 throughout*

Elemental construction cost per m² gross floor area for structural options

July 2009

Trade	Cast in-situ slab method of construction cost	Rate/m²	P.C. Hollow core slab method of construction cost	Rate/m²	Variance	Percentage variance	Rate/m² variance
1. Concrete, formwork and reinforcement	*2,867,774.84*	*1,049.88*	*1,123,395.90*	*411.20*	*(1,744,378.94)*	*-60.83%*	*(638.68)*
2. Masonry	*871,025.71*	*318.88*	*1,042,680.62*	*381.65*	*171,654.91*	*19.71%*	*62.78*
3. Metal work	*0.00*	*0.00*	*778,181.12*	*284.84*	*778,181.12*	*0.00%*	*284.84*
4. Plastering and screeding	*278,881.94*	*102.10*	*247,024.00*	*90.24*	*(31,857.94)*	*-11.42%*	*(11.68)*
5. Painting to slab soffits and steel support	*95,603.42*	*35.00*	*175,726.88*	*64.32*	*80,123.46*	*83.81%*	*29.32*
Sub Total cost (in R)	**4,113.285.92**	**1,505.86**	**3,367,008.52**	**1,232.43**	**(746,277.40)**	**-18.14%**	**(273.42)**
Construction period (weeks)	*34*		*26*				
Est. savings in preliminary related costs for portion of construction under review	*304,761.90*	*111.57*	*0.00*	*0.00*	*(304,761.90)*	*0.00%*	*(111.57)*
Total cost (in R)	**4,418,047.82**	**1,617.43**	**3,367,008.52**	**1,232.43**	**(1,051,039.30)**	**-23.79%**	**(384.99)**



6. TIME RELATED SAVINGS

Speed of construction has additional benefits. It results in savings in cost of site management and on-site activities. It reduces the cost of finance, since a shorter construction period reduces the time during which interest has to be paid. The rapid completion of a building also brings an earlier return on investment. New tenants / home owners can move in sooner, offsetting the cost of lending.

Time related Savings				
Structural Form	**Case Study A – Pretoria**		**Case Study B – Johannesburg**	
	Frame (weeks)	**Overall (weeks)**	**Frame (weeks)**	**Overall (weeks)**
P.C. Hollow-Core slab on load bearing masonry	*12*	*40*	*26*	*52*
In-situ frame	*18*	*46*	*34*	*60*
	Case Study A Saving	*6 weeks*	*Case Study B saving*	*8 weeks*

7. ADDITIONAL SAVINGS

Prestressed members are shallower in depth than their reinforced concrete counterparts for the same span and loading conditions. Usually 65 — 80% of the depth of an equilvalent reinforced concrete member

Prestressed members require less concrete, and about 20-35% of the amount of reinforcement.

Substantial long term savings: lighter foundations can be achieved due to the smaller cumulative weight of the superstructure with the use of precast floor slabs; longer working life due to better quality control of the concrete; less maintenance is needed.

Prestressed concrete becomes mandatory for long spans with better long term performance with regards to shrinkage and creep in comparison with reinforced concrete.

Structural form	**Floor Zone [mm]**	**Hollow-core weight [kN/m²]**	**Hollow-core + 40mm screed weight [kN/m²]**	**In-situ slab weight [kN/m²]**
Case Study A				
P.C. Hollow-core slabs	*120/150/200*	*2.40*/2.75*/3.29**	*3.35**/3.70**/ 4.25***	
In-situ slabs	*255*			*6.10****
Case Study B				
P.C. Hollow-core slabs	*120/150*	*2.40* / 2.75**	*3.35** / 3.70***	
In-situ slabs	*170*			*4.10****
* H/C Slab Self Weight I ** H/C Slab Self Weight + 40mm levelling screed I *** In-situ Slab weight given for depth				

8. TO SUMMARISE ALL THE ADVANTAGES

Precast hollow-core slabs offer considerable advantages over traditional in-situ concrete flooring, making it more and more the preferred choice of flooring solutions.

1. Rapid construction

- *Reduced construction time*
- *Ready to use working platforms*
- *Elimination of temporary structures including propping*
- *No plastering of ceiling*
- *Elimination of long and continuous concrete pouring operations*
- *No propping or back propping required allowing the finishes to take place at the lower levels*
- *No rework due to unskilled labour*
- *Early occupation = money in the bank*

2. Minimal disruption

- *Hollow-core slabs produced in a controlled factory environment, delivered to site and immediately installed. No on-site storage required, this is ideal for small and confined construction sites.*
- *Hollow-core slabs construction can dramatically reduce the impact of building activities on the surrounding area.*
- *Minimized noise and dust, shortens the construction period and reduces the amount of wastage generated.*

3. Flexible solution

- *Long slab spans reduce the number of vertical rising elements in the building and offer flexibility of internal layout. It means the building can be configured to incorporate any combination of large open plan areas.*

4. Built in quality

- *Off-site manufacture according to SABS Standards improves the quality of the building frame, since work is carried out under closely controlled factory conditions, where it is not affected by on-site trades or the weather. All this leads to just in time delivery/right the first time.*

5. Environmental benefits

- *Hollow-core is the only precast flooring element that can be recovered from a building and re-used.*
- *All the materials used can be recycled.*
- *Hollow-core is a clean and efficient construction method which reduces the impact of building activities on the environment, the small amount of waste produced is recycled and used in other precast product.*
- *The carbon footprint is less than produced in-situ.*

Hollow-core slab producer members (September 2009)

Echo Floors	011 662 4600
Echo Prestress	011 589 8800
Echo Prestress Durban	031 569 6950
Shukuma Flooring Systems	041 372 1933
Stabilan	051 434 2218
Topfloor	021 552 3147

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