BEHAVIOR AND SUSTAINABILITY OF BUBBULED REINFORCED CONCRETE SLABS

By

Lect. Dr. Wissam D. Salman

Bubbled RC Slab System

Introduction

In building, the slab is very important structural member to make a space. And the slab is one of the largest member consuming concrete. When span of the building is increasing, deflection of slab is more important. Therefore, the slab thickness is on the increase. The increasing of slab thickness makes slab heavier, and it leads to increase column and foundation size. The Bubbled Reinforced Concrete Slab System, also known as Voided Slab System, was recently introduced in the Europe. This system consist of hollow plastic spheres cast into the concrete to create a grid of void forms inside the slab and could optimize the size of bearing walls and columns by reducing the weight of slabs.

Introduction

The bubbled RC slab system has a major contribution to the objective of "sustainable building" by:

1. Saving on the use of primary raw materials, the flexibility offered in the lay-out of the building and the making of passages and recesses and, finally: in the event of demolition a substantially smaller amount of concrete granulate and recyclable polymer spheres which do not adhere to the concrete.
2. Smaller amounts of concrete have to be transported by road and smaller amounts of cement, sand and gravel have to be transported by road and by water.
3. Saving on energy and emissions concerning the production and transport of building materials.

Materials of Bubbled RC Slabs

Steel-

Plastic Spheres-

Concrete-

Thickness of Bubbled RC Slabs

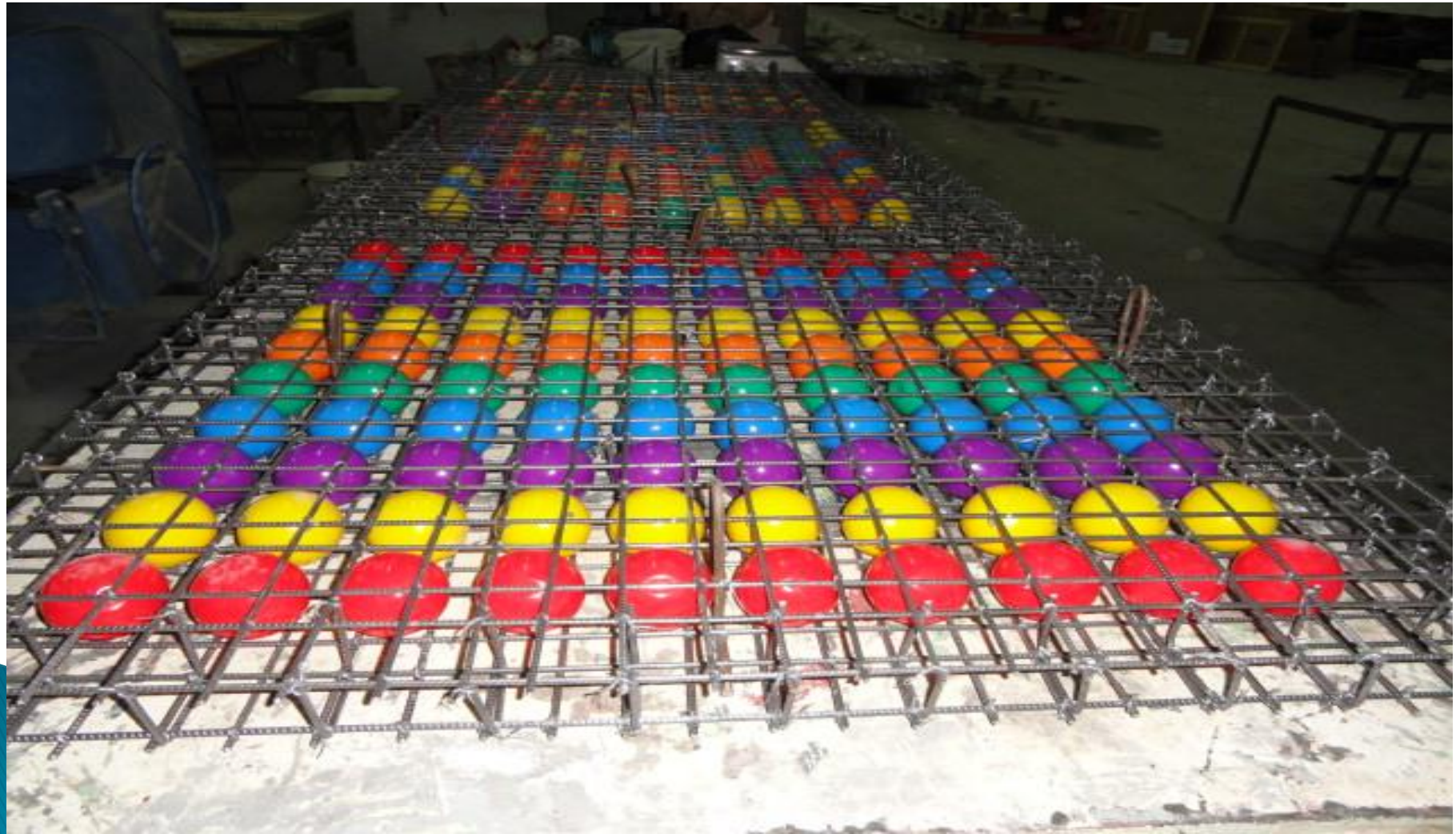
There are seven standard thicknesses for bubbled RC slabs, which vary from 230mm to 450mm, and up to 510mm and 600mm for specific designs.

Versions of Bubbled RC Slabs

Version	Slab Thickness (mm)	Bubble Diameter (mm)	Center-to- Center Spacing Between Bubbles (mm)	Span (Multiple Bays) (m)	Span (Single Bays) (m)	Cantilever Maximum Length (m)
BD230	230	180	200	5 – 8.3	5 – 6.5	≤ 2.8
BD280	280	225	250	7 – 10.1	6 – 7.8	≤ 3.3
BD340	340	270	300	9 – 12.5	7 – 9.5	≤ 4.0
BD390	390	315	350	11 – 14.4	9 – 10.9	≤ 4.7
BD450	450	360	400	13 – 16.4	10 – 12.5	≤ 5.4
BD510	510	405	450	15 – 18.8	11 – 13.9	≤ 6.1
BD600	600	450	500	16 – 21.0	12 – 15.0	≤ 7.2

Types of Bubbled RC Slabs

- Type A- Reinforcement Modules (Simple Type)

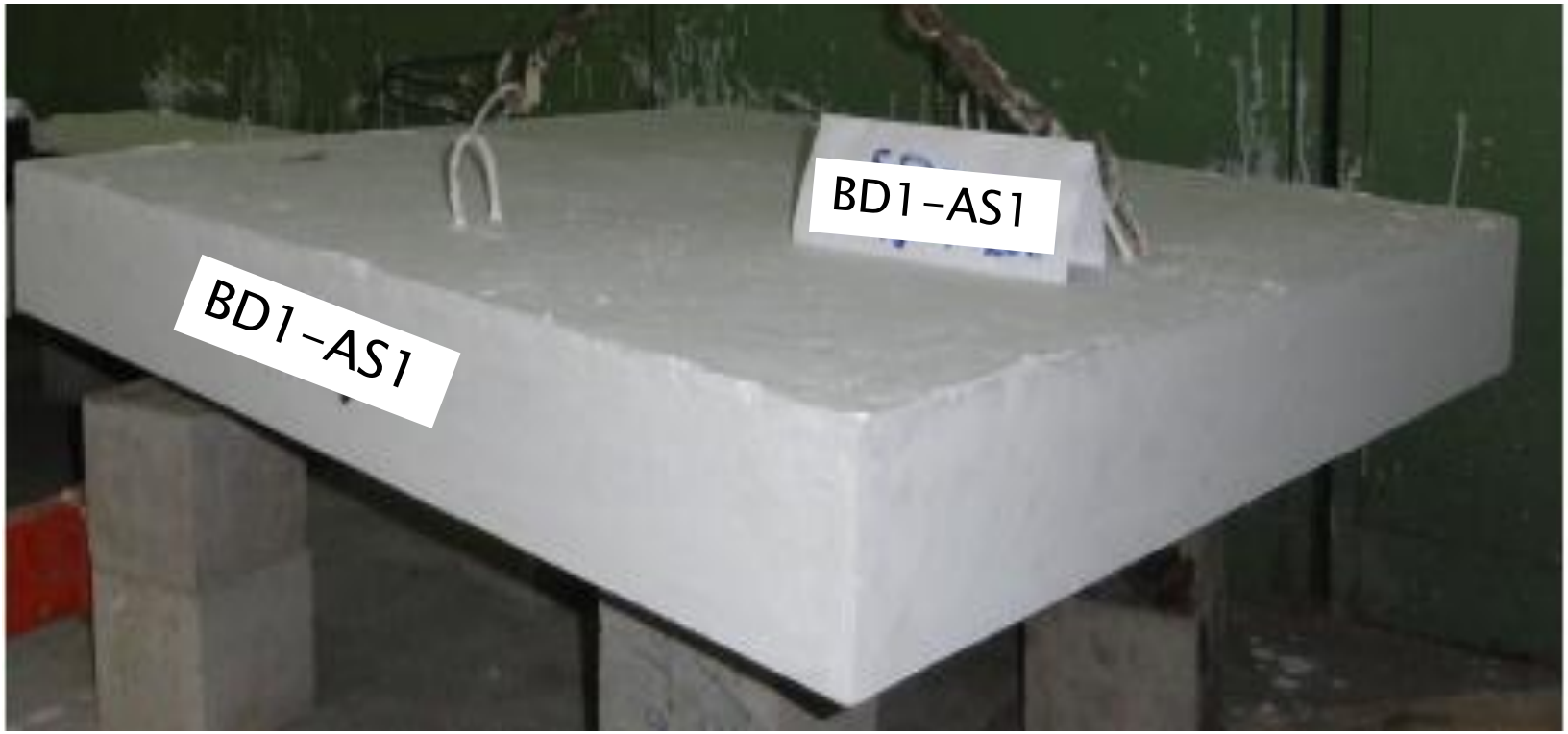


Types of Bubbled RC Slabs

- Type B-Filigree Elements (Semi-Precast Type)

Types of Bubbled RC Slabs

- Type C-Finished Planks (Precast Type)



SUSTAINABILITY OF BUBBLED R.C SLABS

The “sustainable” is defined as the capability of being maintained at a steady level with minimum long-term effect and less causing ecological effect. Construction field relates to a large amount of material use, energy generation, heat producing and pollution as well as waste. To minimize the harm to the environment, one of the significant methods is by adopting the “sustainable element” into construction activities. The energy consumption during the production of bubbled RC slabs is comparable by nature to the energy consumption of similar solid RC slabs systems. The greatest part of the energy consumption concerns the production of the raw materials cement, sand, gravel and reinforcing steel. These productions take place in existing cement factories and concrete products factories which play a pioneer's role in the reduction of the energy consumption. From the viewpoint of energy saving, however, the most important aspect is the substantial savings if the bubbled RC slab system is used instead of comparable solid RC slab systems. These result in a quantitative sense in an almost proportional saving on energy consumption, i.e. proportional to the saving in materials quantities.

SUSTAINABLE ANALYSIS OF POLYMER BUBBLED RC SLABS

Comparison between Required Quantities of Raw Materials and Saving Achieved by Using the Polymer Bubbled RC Slab System and a Solid RC

Material	Solid RC Slab (Thickness 100mm) SD2	Bubbled RC Slab (Thickness 100mm) (BD2-bu80)	Bubbled RC Slab (Thickness 80mm) (BD1-Met.10%)
Sand	73 kg/m^2 (100%)	50 kg/m^2 (68%)	41 kg/m^2 (56%)
Gravel	102 kg/m^2 (100%)	70 kg/m^2 (68%)	58 kg/m^2 (56%)
Cement	43 kg/m^2 (100%)	30 kg/m^2 (69%)	21.4 kg/m^2 (49%)
Metakaolin	--- (0%)	--- (0%)	2.6 kg/m^2
Water	23 kg/m^2 (100%)	16 kg/m^2 (69%)	12 kg/m^2 (52%)
Reinforcement Steel	12 kg/m^2 (100%)	12 kg/m^2 (100%)	12 kg/m^2 (100%)
Recycled Plastic	--- (0%)	2 kg/m^2	2 kg/m^2

The Sustainable Benefits of the Bubbled RC Slabs

Comparison of Embodied Energy and CO_2 Emissions Achieved by Using the Bubbled RC Slab System Versus a Solid RC Slab

Material	Solid RC Slab (Thickness 100mm) SD2		Bubbled RC Slab (Thickness 100mm) (BD2-bu80)		Bubbled RC Slab (Thickness 80mm) (BD1-Met.10%)	
	Embodied Energy (MJ)	CO_2 Emissions (kg)	Embodied Energy (MJ)	CO_2 Emissions (kg)	Embodied Energy (MJ)	CO_2 Emissions (kg)
Sand	7.30	0.511	5.0	0.35	4.10	0.287
Gravel	4.08	0.204	2.8	0.14	2.32	0.116
Cement	264.88	42.742	184.8	29.82	131.82	21.270
Reinforcement Steel	375.72	14.900	375.72	14.90	375.72	14.90
Total	651.98 (100%)	58.357 (100%)	568.32 (87%)	45.21 (77.4%)	513.96 (78.8%)	36.573 (62.6%)

Thanks for Listening