Why Buildings Fall Down: Some Stories from Materials Science

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Faculty of the Built Environment
Uganda Martyrs University

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Faculty of the Built Environment, Uganda Martyrs University, Kampala, Uganda

UNIVERSITY OF CAMBRIDGE
KMUTT King Mongkut's University of Technology Thonburi
The University of Nottingham Ningbo, China
NHBRA TANZANIA
THE UNIVERSITY OF WARWICK
EPSRC Engineering and Physical Sciences Research Council
DFID Department for International Development
DEPARTMENT OF ENERGY & CLIMATE CHANGE
Faculty of the Built Environment

The **Art[s] teaches us nothing**

Henry Miller

The “**Art[s] teaches us nothing, except the significance of life**”

Henry Miller

Background

- Reports of buildings collapsing are now ubiquitous

- After each incident, there are claims, blames and threats

- But each subsequent year another building comes down

Background

- What are some of the reasons for this?
- More often than not the blame is placed on the Architects, Engineers and the Municipality
- But is this the extent of the problem

what is the primary material of this wall?

What is our appreciation of what is going on?

“All small hardware shops in Uganda master the craft of opening and perfectly sealing the [cement] bags. The honest ones just reduce the quantity. The bad ones mix in other things” (Buwembo, 2009: 14)

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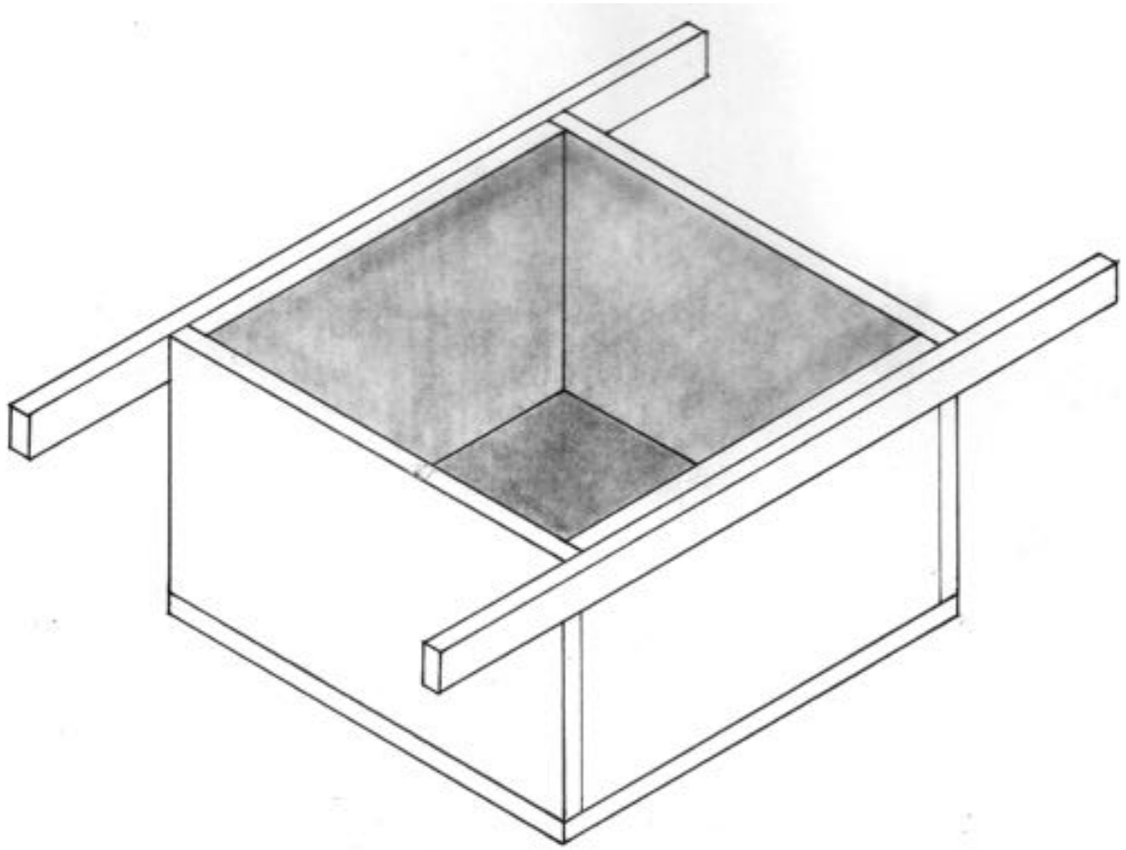
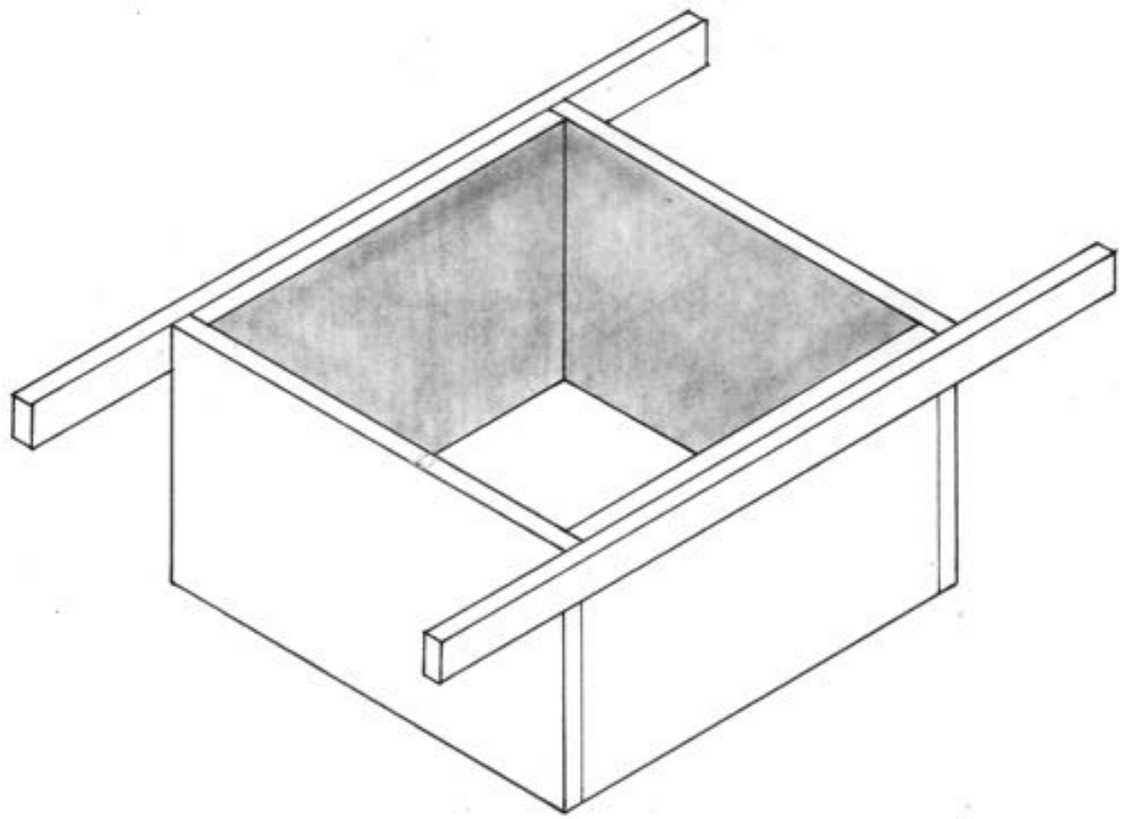
Making Concrete

"Concrete can be proportioned by volume using a box, commonly known as a gauge box. The gauge box has an open bottom. No particular dimensions are prescribed. Hence, the box is of flexible dimensions to facilitate handling, as long as the same one is used throughout."

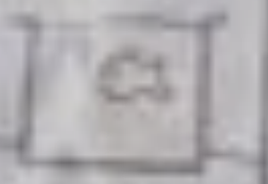
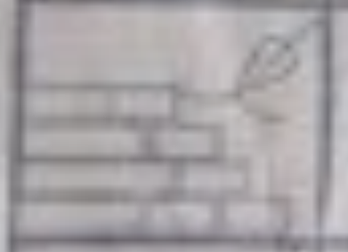
.... The main applications are: **NON STRUCTURAL**





Measuring Box
Measuring Frame

SUGGESTED MIXING PROPORTIONS BY VOLUME

APPLICATIONS				
	High strength and watertight concrete, columns, driveways and carports	1	2	2
	Medium strength concrete floors, beams, slabs, patios, footpaths etc.	1	2	4
	Low strength concrete foundations and footings.	1	3	6
	General purpose mortar and plaster exposed to dampness (Exterior).	1	4	—
	General purpose mortar and plaster not exposed to dampness (Interior)	1	6	—

RECOMMENDED MIX PROPORTIONS

HIMA CEMENT IS SUITABLE FOR:	NUMBERS DENOTE VOLUME PROPORTIONS		
	CEMENT	SAND	AGGREGATE
STRUCTURAL APPLICATIONS / REINFORCED CONCRETE (Suspended slabs, water tight concrete, heavy duty industrial floors) 	1	1	2
UNREINFORCED CONCRETE (Foundations, footings, domestic floors - unreinforced)	1	1½	3
MORTAR FOR BRICKLAYING	1	3	—
MORTAR FOR PLASTERING	1	4	—

NOTE USE THE SAME SIZE CONTAINER FOR MEASURING ALL THE MATERIALS IN A BATCH - SEE VOLUME PROPORTIONS ABOVE.

Concrete Batching

	Mix 1		Mix 2 (1:2:4)		Mix 3	
	kg/batch	**part.vol. (ℓ)**	**kg/batch**	**part.vol. (ℓ)**	**kg/batch**	**part.vol. (ℓ)**
med.aggr.	17.5	6.481	21.269	7.877	21.144	7.831
fine aggr.	17.5	6.481	20.62	7.637	20.537	7.606
sand	23.31	8.633	21.983	8.142	21.647	8.017
cement	15.05	5.19	8.538	2.944	10.667	3.678
water	7.525	7.525	6.7	6.7	6.7	6.7
air*	-	~0.7	-	~0.7	-	~0.7
total	80.885	35.01	79.11	34	80.695	34.532

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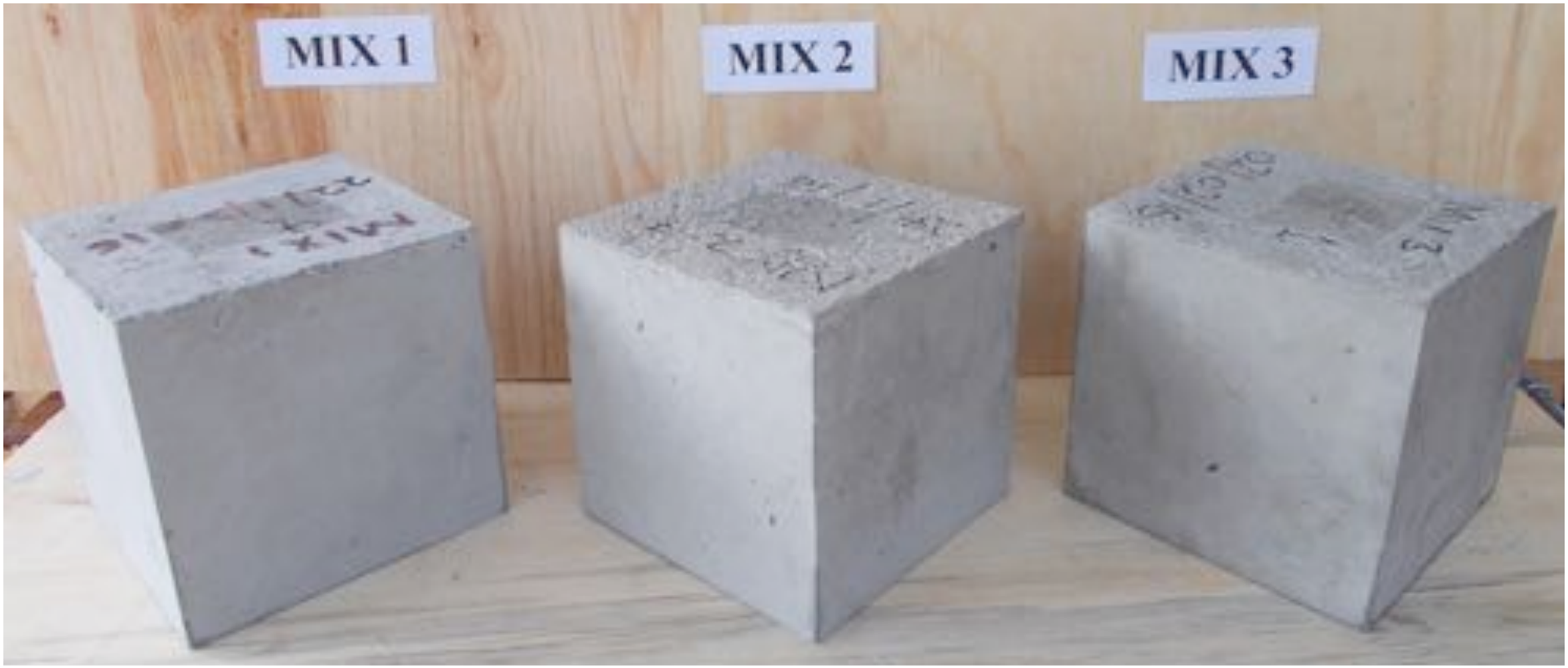
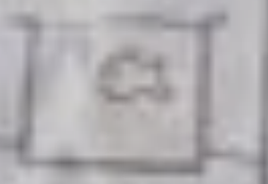


Concrete Batching

	Mix 1		**Mix 2 (1:2:4)**		**Mix 3**	
	density (kg/m^3)	**strength (N/mm^2)**	**density (kg/m^3)**	**strength (N/mm^2)**	**density (kg/m^3)**	**strength (N/mm^2)**
7 days	2315	25.8	2325	13.4	2340	19.7
14 days	2290	29.7	2315	17.8	2330	25.4
28 days	2300	34.2	2290	20.5	2310	28.1
Calculated		**32.9**		**19.7**		**27.0**

SUGGESTED MIXING PROPORTIONS BY VOLUME

APPLICATIONS				
	High strength and watertight concrete, columns, driveways and carports	1	2	2
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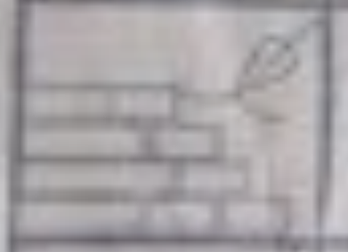	General purpose mortar and plaster exposed to dampness (Exterior).	1	4	—
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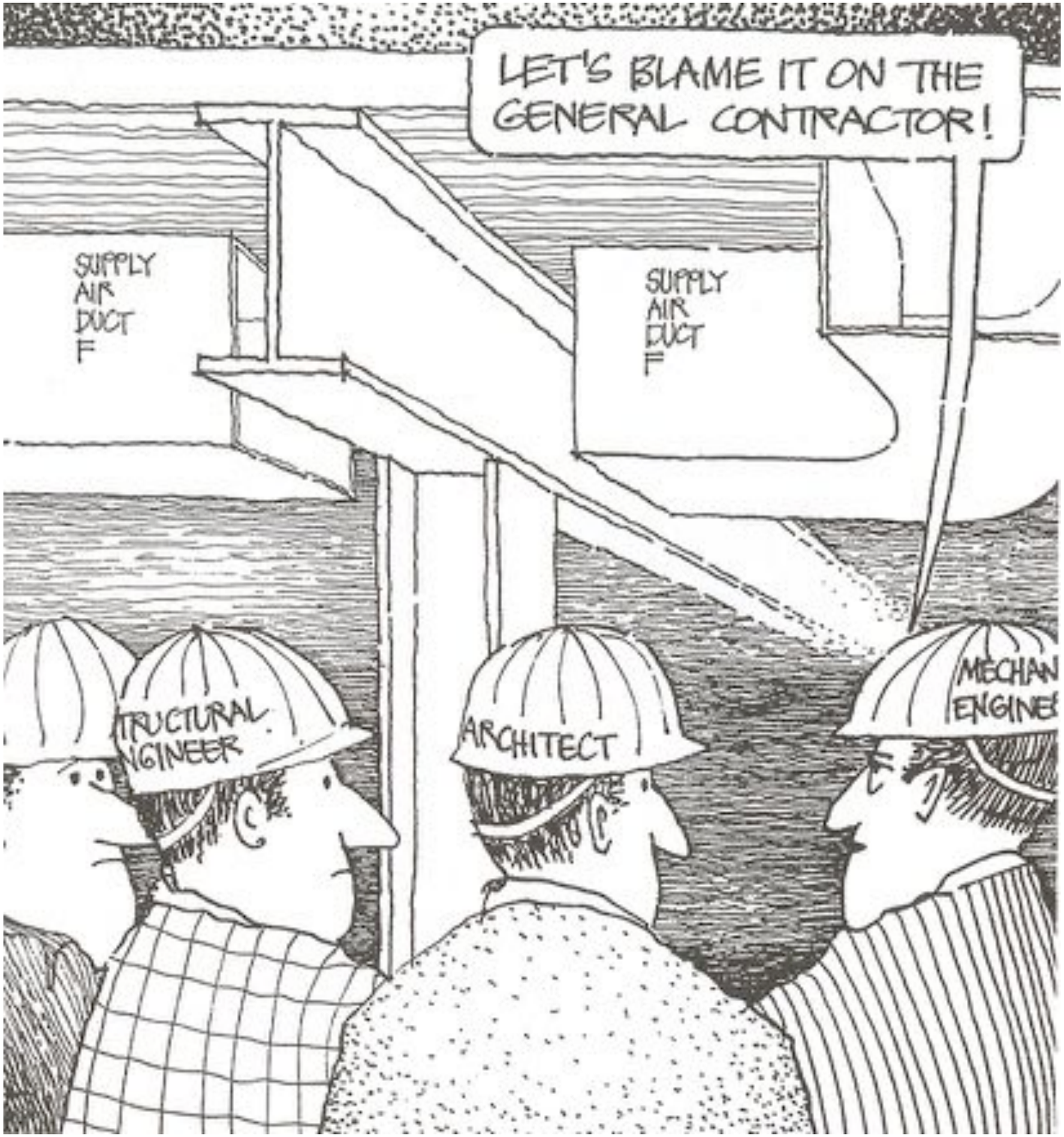
Concrete Batching

	MIX 1		MIX 2 (1:2:4)	MIX 3	
Cement Content (kg/m^3)	430		251	309	
	1:1:2	**1:2:2**	**1:2:4**		**1:3:6**
Cement Content (kg/m^3) - Cal.	475	377	265		185


WHY BUILDINGS COLLAPSE in UGANDA
@ CONSTRUCTION
Workers, labourers & Supervisors are lazy, incompetent, careless, and some just don't care
@ SUPPLIERS
Hardware Shops bring to the market Fake materials
@ MATERIALS & BUILDING LAB
Technicians & Experts doctor the results for money
TESTS
@ BUILDING PERMISSION
Developer Bribes Authority for Permission
@ CONTRACTOR SELECTION
Builder Bribes Tender Committee with 'Envelope'
@ DESIGN TEAM SELECTION
Choose friends, family, networks,
Architects / Engineers forget what they learnt in School
@ INCEPTION
Community Needs out
Selfish Profit in
DEVELOPER wants to Cut Costs
THE BUBBLE IS GOING TO BURST


LET'S BLAME IT ON THE GENERAL CONTRACTOR!
SUPPLY AIR DUCT F
SUPPLY AIR DUCT F
TRUCTURAL NGINEER
ARCHITECT
MECHAN ENGINE

Educational approach ...

“In the end, education’s most essential mission is to develop within each student the capacity not only to build with competence, but to judge wisely in matters of life and conduct.”

(Boyer and Mitgang, 1996)