Analysis of Embodied Energy and Carbon Emissions of Column Structure by Using Life Cycle Assessment (LCA) Technique -

case study: School of Dentistry, Brawijaya University Construction Project

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Introduction

Concrete as construction materials contribute to $^{2}/_{3}$ of total CO2 emissions

High-rise building is one of the main producers of carbon emission

High-rise buidling has a large volume of concrete work, which relates to its high rate of energi consumption

The emission source of transporting construction materials is based on diesel fuel of concrete mixer trucks, while enery consumption on project site is mainly related to the use of heavy equipment, such as tower crane.

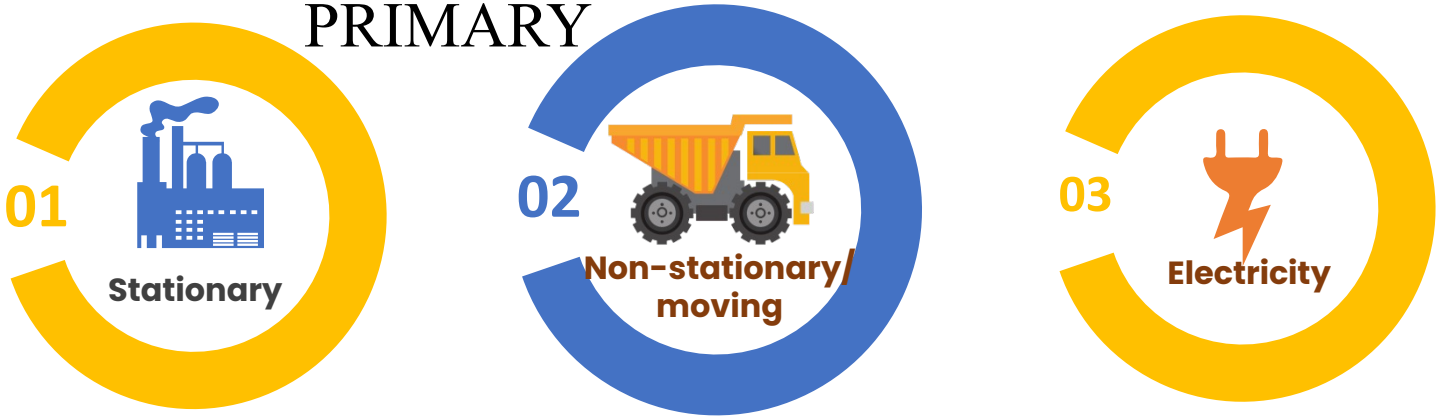
Green House Gases (GHG) released from energy consumption contribute to the increasing earth's average temperature.

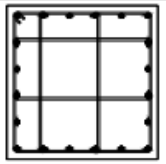
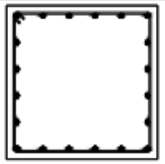
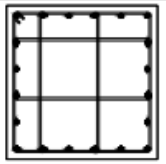
Method

The research is aimed to quantify CO2 emissions from the construction project of Faculty of Dentistry Building, Brawijaya University by using Life Cycle Assessment technique.

PRIMARY

SECONDARY



TYPE KOLOM	K-3		
Posisi	BAWAH (1/4 L)	TENGAH (1/2 L)	ATAS (1/4 L)
Potongan			
Dimensi	80 x 80 cm		
Tul. Utama	20 - D22		
Sengkang	D10 -100	D10 -100	D10 -100
Cross Ties	4D10 -100	-	4D10 -100

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Method

CONCRETE MATERIALS AND PRODUCTION STAGES

01 COLUMN DIMENSION AND LOCATION

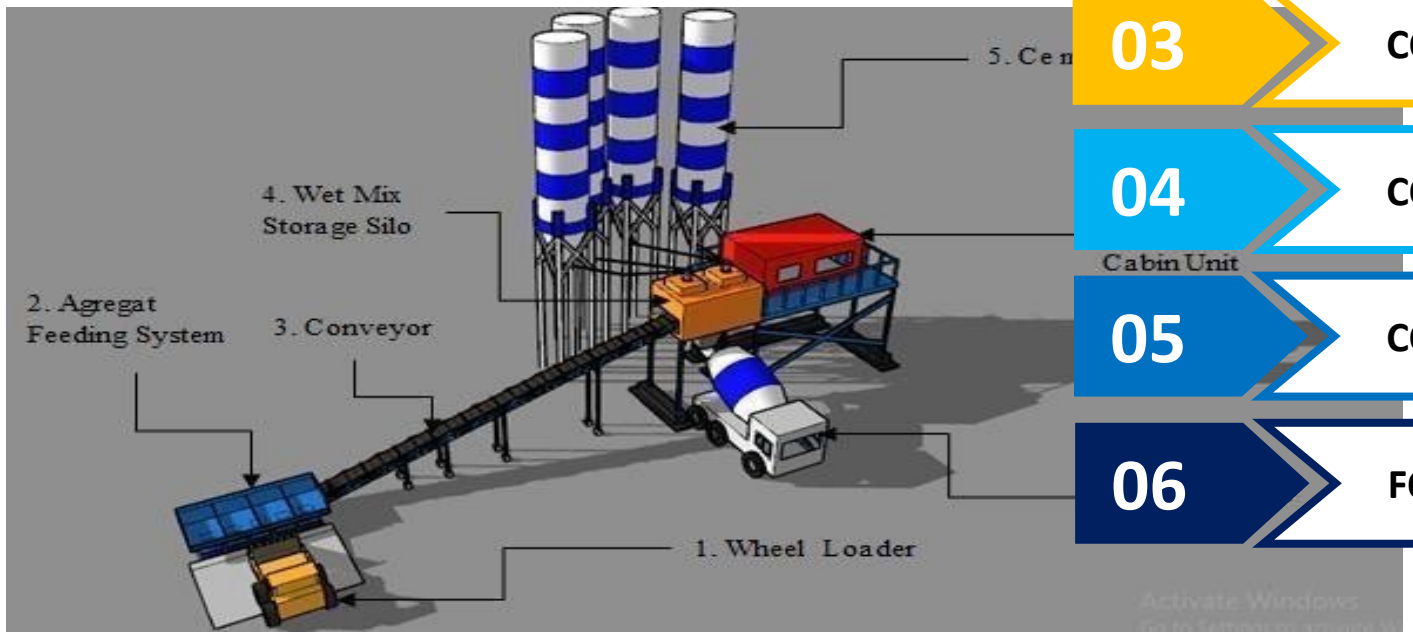
02 COLUMN REINFORCEMENT

03 COLUMN BASE

04 COLUMN FORMWORKS

05 CONCRETE POURING

06 FORMWORKS DISMANTLE



MATERIAL COLLECTION → MATERIAL MEASUREMENT → MATERIAL MIXING - PAN → MATERIAL MIXING - TRUCKS → DISTRIBUTION

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CONCRETE MATERIALS AND PRODUCTION STAGES

Method

READYMIX CONCRETE DISTRIBUTION

CONCRETE POURING

CONCRETE DISTRIBUTION

CONCRETE POURING

CONCRETE MIXER TRUCKS

POURING – TOWER CRANE AND CONCRETE PUMPS

Concrete vibrator

FINISH

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Calculation of energy consumption and GHG emission (primary and secondary)

Production stages

Result and Discussion

Start

1st

Fuel consumption: $403\ x\ 10^{-7}$ TJ

Wheel Loader

Output CO2 : 2,986 kg

2nd

Electrical consumption: 0,447 kWh

Conveyor

Output CO2 : 0,389 kg

3rd

Electrical consumption: 0,671 kWh

Conveyor Miring

Output CO2 : 0,584 kg

4th

Electrical consumption: 0,26 kWh

Pan Mixer

Output CO2 : 0,23 kg

5th

Fuel consumption: $216\ x\ 10^{-8}$ TJ

Truk *Mixer*

Output CO2 : 0,16 kg

6th

Electrical consumption: 0,386 kWh

compressor

Output CO2 : 0,32 kg

Result and Discussion

Calculation of energy consumption and GHG emission (primary and secondary)

Pouring stage

Fuel consumption: $374\ x\ 10^{-6}$ TJ

Truk *Mixer*

Output CO2 : 28 kg

7th

Electrical consumption: 10,56 kWh

Tower Crane

Output CO2 : 9,187 kg

8th

9th

10th

Finish

Fuel consumption: $244\ x\ 10^{-7}$ TJ

Truk *Mixer*

Output CO2 : 1,8 kg

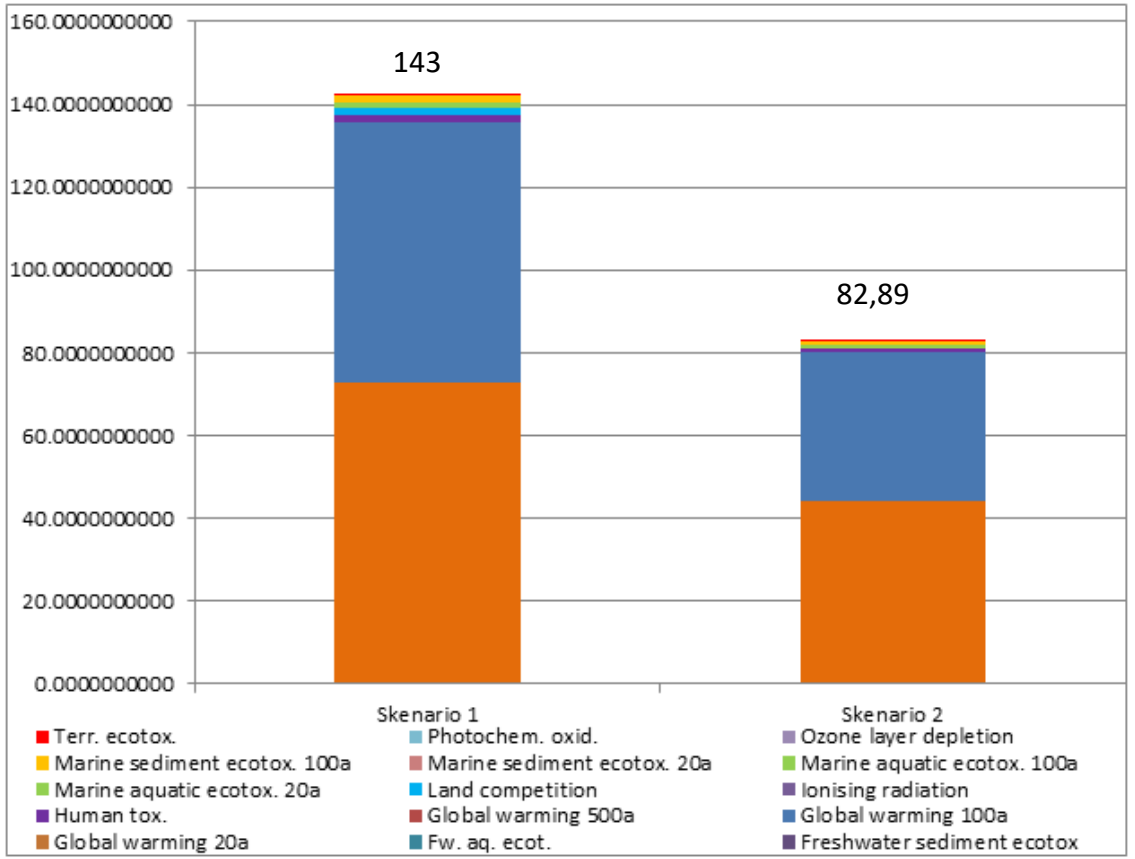
Electrical consumption: 0,82 kWh

Concrete Vi

Output CO2 : 0,71 kg

Result and Discussion

No.	Indicator	Skenario 1	Skenario 2	Persentase	Unit
1	Global warming 20a	72.63	44	17%	kg CO2 eq
2	Global warming 100a	62.74	36	19%	kg CO2 eq
3	Human tox.	1.70	0.99	11%	kg 1,4-DB eq
4	Land competition	1.62	0	100%	m2a
5	Marine sediment ecotox. 100a	1.34	0.75	3%	kg 1,4-DB eq
6	Marine aquatic ecotox. 100a	1.03	0.63	7%	kg 1,4-DB eq
7	Marine sediment ecotox. 20a	0.37	0.25	8%	kg 1,4-DB eq
8	Marine aquatic ecotox. 20a	0.20	0.13	10%	kg 1,4-DB eq
9	Freshwater sediment ecotox	0.14	0.042	50%	kg 1,4-DB eq
10	Acidification	0.08	0.038	25%	kg SO2 eq
11	Freshwater aquatic ecotoxicity	0.07	0.02	57%	kg 1,4-DB eq
12	Eutrophication	0.05	0.018	38%	kg PO4--- eq
13	Terrestrial ecotoxicity	0.035	0.0036	83%	kg 1,4-DB eq
14	Photochemical oxidation	0.017	0.014	90%	kg C2H4 eq
15	Ozone layer depletion	9.7x10^-6	5.7x10^-7	91%	kg CFC-11 eq
16	Abiotic depletion	2.7x10^-8	3.1x10^-9	89%	kg Sb eq
17	Ionising radiation	2.2x10^-8	1.3x10^-8	9%	DALYs
18	Global warming 500a	0	0	0%	kg CO2 eq
Total keseluruhan		143.17	82.89	42%	



Conclusion

- The energi consumption in the life cycle of column works at the studied project includes 12.126 KWh from electrici ty and 0.0004412 TJ diesel fuel use TJ (12.26 litre)

The biggest CO2 emissions coming from distribution stage with 44.4 kg of CO2 or 64%, followed by pouring stage (26%) and concrete producti on stage (10%). The column structural works also contribute to 14 poten tial impacts of environment; **GWP 20a (51%), GWP 100a (44%), hu man toxicity (1,2%), land competition (1,14%), marine sediment ec otoxicity 100a (0,95%), marine aquatic ecotoxicity 100a (0,73%), m arine sediment ecotoxicity 20a (0,26%), marine aquatic ecotoxicity 20a (0,14%), freshwater sediment ecotoxicity (0,10 %), acidification (0,06%), freshwater aquatic ecotoxicity (0,05%), eutrophication (0, 04%), terrestrial ecotoxicity (0,025%), photochemical ecotoxicity (0, 012%), ozone layer depletion (0,000000069%), abiotic depletion (1,9 x 10^{-10}%), ionising radiation (1,5 x 10^{-10}%), GWP 500a (0%).**

Thank you

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