Questionnaire:

Sustainability of Concrete Steel in Tall Buildings – Doha, Qatar

Introduction

"This research/publication was made possible by a National Priority Research Program NPRP award [NPRP- 7 - 1518 - 2 – 549] from the Qatar National Research Fund (a member of The Qatar Foundation). The statements made herein are solely the responsibility of the author(s)."

This survey is being undertaken as part of a research project NPRP7-1518-2-549 on the "Multi-objective tall building topologies – Optimizing for structural performance, economy, and sustainability in Doha, Qatar" – Lead PI Dr. Fodil Fadli.

Traditional structural design optimization algorithms have the goal of minimizing total material usage while satisfying structural design code requirements. This has a tendency to produce "lightweight" solutions that are unfortunately complex, often ending up more expensive to construct making them undesirable or impractical. This survey is to obtain data regarding the steel used in the concrete as rebar to build tall building with the objective to run an LCA studies targeting to analyze the total environmental burden and so looking for solutions and suggestions to mitigating it.

The goal of this survey is to assist by bringing constructability metrics into the design optimization methodology such that optimized solutions are more practical and economical than currently available. Responses are requested on the important types of construction metrics, and how different construction metrics may effect cost. The survey results will discover issues and provide solutions to enhance sustainability methods of concrete steel in tall building. It will further assist urban planners in their future decisions and planning vision for high rise sustainable buildings. It is also important to note that the answers to the following questions shall be concerned only to Qatar.

Kindly be informed that all information collected through this survey will be treated as strictly confidential and will be used only for research purposes. No information about the individuals who have participated in this survey will be disclosed to anyone at any time. (This questionnaire has been tested and will require 5 minutes of your time). Please note that participation is voluntary, you can skip any question or withdraw at any time. Once finished all participants will receive a copy of the results and analysis.

General Information						
1.1.	Name:					
1.2.	Country:					
1.3.	Age:	**A.** 20 – 30	**B.** 30 – 40	**C.** 40 – 50	**D.** 50 – 60	**E.** 60 & over
1.4.	Company Name:					
1.5.	Specialization:	**A.** Structural	**B.** Civil	**C.** Architecture	**D.** Energy & Sustainability	

The questionnaire form (tick suitable answer)

I. Quantity Discounts for Repeating Section Sizes

Q1: a. Is having all floor joists the same size advantageous over having every floor joist be a different size even if this uses less material?

□ Yes □ No

b. Which structural design does this apply to most?

□ Steel □ Concrete □ Steel and Concrete

Q2: The following is a Quantity Discount table showing potential cost savings for ordering more steel; often referred to as a "volume discount". The table shows discount rates for ordering larger quanties of the same section, and corresponding plot showing the price as a percentage of the base cost per number of members ordered.

Quantity Discounts:

6 - 10:	5.00%
11 - 20:	9.00%
21 - 50:	13.00%
51 - 100:	17.00%
101 +:	21.00%

**Add to Cart for discount to be applied to pricing.*

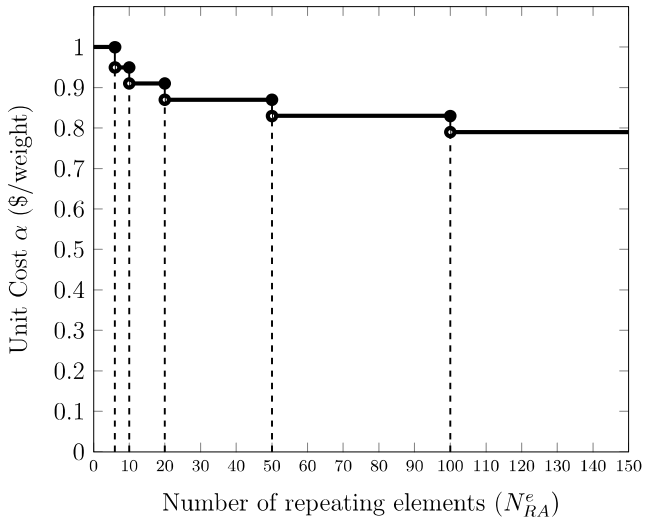


Figure 1. Prices

a. Do you encouter similar pricing schemes?

□ Yes □ No

b. Are these reasonable numbers?

□ Yes □ No

c. Do the sections have to be the same size to realize such a discount (e.g. multiple W12x26)? (as opposed to just total quantiy ordered)

□ Yes □ No

d. Do the above questionas enter your decision process when assigning structural sections to a framing plan?

□ Yes □ Intermediate □ No

e. Do these same ideas hold for pour-in-place concrete design?

□ Yes □ No

If yes, what are the reasons (construction simplicity, re-use of formwork, etc): _____

_____

f. What is the relationship between the discount rates of the pour-in-concrete and steel design?

□ Similar □ More □ Less

II. Price Premiums for Non-Standard Section Sizes

Deviating from the standard section sizes, or even from commonly mass-produced section sizes, comes at a cost premium.

Q1: Steel Construction

a. Are there certain section sizes that are cheaper (per pound of steel) because they are mass produced?

□ Yes □ No

If yes, what is it? _____

b. What is a typical cost premium for ordering a similarly-sized section that is not in Figure 1 above?

c. Is there a maximum size (either by section dimensions or cross-sectional area) that you would never use in practice?

□ Yes □ No

If yes, what is it? _____

d. What is a typical cost premium for ordering an over-sized section that is not typically mass-produced?

_____

e. Does this premium vary based on size?

□ slightly over-sized is 20% more expensive per pound of steel

□ moderately over-sized is 60% more expensive per pound of steel

□ highly over-sized is 150% more expensive per pound of steel

Q2: Reinforced Concrete Construction

a. Are there certain rebar sizes that are cheaper (per pound of steel) because they are mass produced?

□ Yes □ No

b. What is a typical cost premium for ordering a similarly-sized rebar section that is not on this list?

c. Is there a maximum rebar size (either by section dimensions or cross-sectional area) that you would never use in practice?

□ Yes □ No

If yes, what is it? _____

d. What is a typical cost premium for ordering an over-sized rebar section that is not typically mass-produced? _____

i. Does this premium vary based on size?

□ slightly over-sized is 20% more expensive per pound of reinforced concrete

□ moderately over-sized is 60% more expensive per pound of reinforced concrete

□ highly over-sized is 150% more expensive per pound of reinforced concrete

III. Construction Complexity

The more members that are connected at a location, the higher the relative connection cost.

Q1. a. Do member connecting at angles other than 0/90/180/270/360 degrees cost less than members connecting at non-perpendicular orientations? For example, 15, 30, 45, 60, 75 degrees?

□ Yes □ No

If yes, is there an approximate percentage you could estimate this premium to be? _____

Q2. a. Is there a cost difference for a welded connection over a bolted connection?

□ Yes □ No

b. If so, which connection costs more?

□ Welding □ Bolting

What is the relative difference in percentage? _____

Q3. a. Assuming section sizes are compatible and the same connection type (rigid/ pin, bolt/ weld), if 2 members connecting at a point (one connection) costs X, specify the approximate cost of the following (i.e. 2X, 3X, etc.)

i. 3 members (two connections): _____
ii. 4 members (three connections): _____
iii. 5 members (four connections): _____
iv. 6 members (five connections): _____
v. 7 members (six connections): _____
vi. 8 members (seven connections): _____

b. Do these estimates assume steel or concrete? Please identify _____

_____

c. Do these estimates assume rigid or pin connection? Please identify _____

_____

d. Do these estimates assume bolt or weld (if steel)? Please identify _____

_____

e. Do these estimates change with location within building (i.e. exterior vs. interior)?

□ Yes □ No

f. Do these estimates change as a function of story number (height) in building?

□ Yes □ No

Q4. a. For concrete beams, steel reinforcement is predominately placed as horizontal or vertical (stirrups), which is structurally inefficient but relatively straight forward to construct?

□ Vertical □ Horizontal □ Vertical and Horizontal

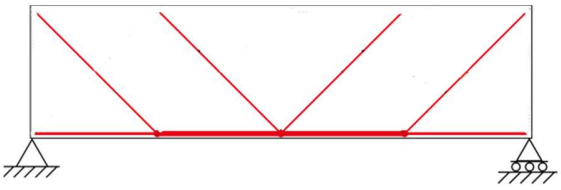
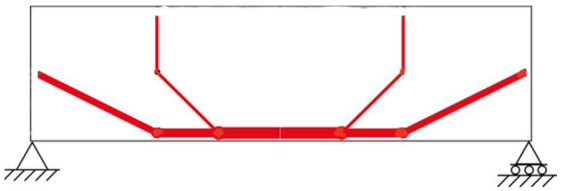
b. Can rebar be placed at various angles along the beam length? For example, at midspan, placing rebar at an angle of 20 degrees?

□ Yes □ No

c. If so, would you allow the angle to be variable along the span? Such as 20 degrees at midspan and 45 degrees at quarter span?

□ Yes □ No

Q5. Following onto question 4 (Q4), consider the two rebar patterns below shown in red.

(a)  (b) 

a. Understanding that additional detailing will be required, which design would you consider?

□ Design "a" □ Design "b" □ Both "a&b" □ Neither "a/b"

Why or why not? _____

b. Approximately how much of a cost premium would you anticipate for designing and building (a) and (b) compared to a traditional design of horizontal rebar and vertical stirrups?

_____

c. Although it is not the same case, assume that steel material costs are identical to the tradition design. How would you rate the cost premium?

□ 0-20% more expensive than traditional

□20-40% more expensive than traditional

□ 40-60% more expensive than traditional

□60-80% more expensive than traditional

□ 80-100% more expensive than traditional

Date:

THANK YOU FOR YOUR TIME AND PATIENCE