Bridge LCCA

Overview & Implementation

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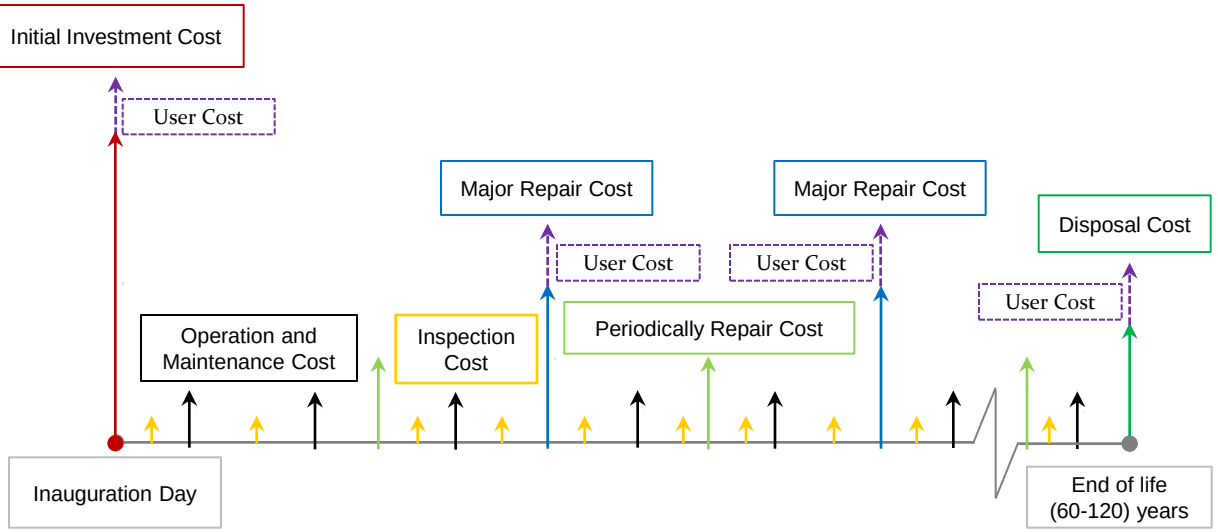
TRAFIKVERKET

Agenda

- Introduction
- Benefits of BaTMan & WebHypris for Bridge LCCA
- Bridge Life & the Possible LCCA Applications for Bridges
- Bridge Investment Case Studies & Large-Scale Feasibility
    - App. No. (1): The Optimal Road Corridor, Bridges
    - App. No. (2): The Optimal Bridge Design Proposal
    - App. No. (3): Repair or Replace a Bridge?
- BaTMan-LCC Program & BaTMan-LCC Course
- Questions & Discussion

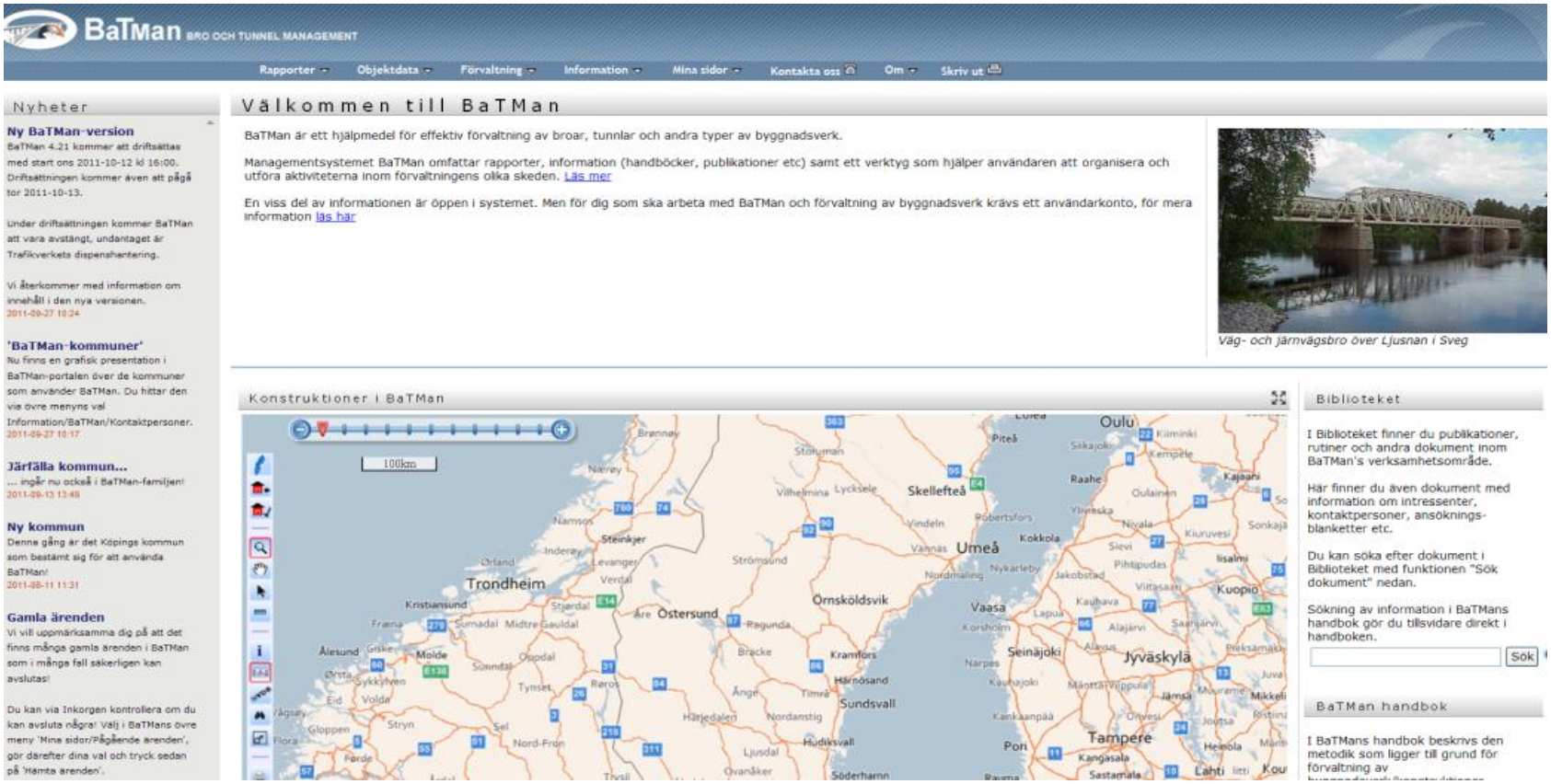
Introduction

- Bridge **L**ife-**C**ycle **C**ost (LCC)



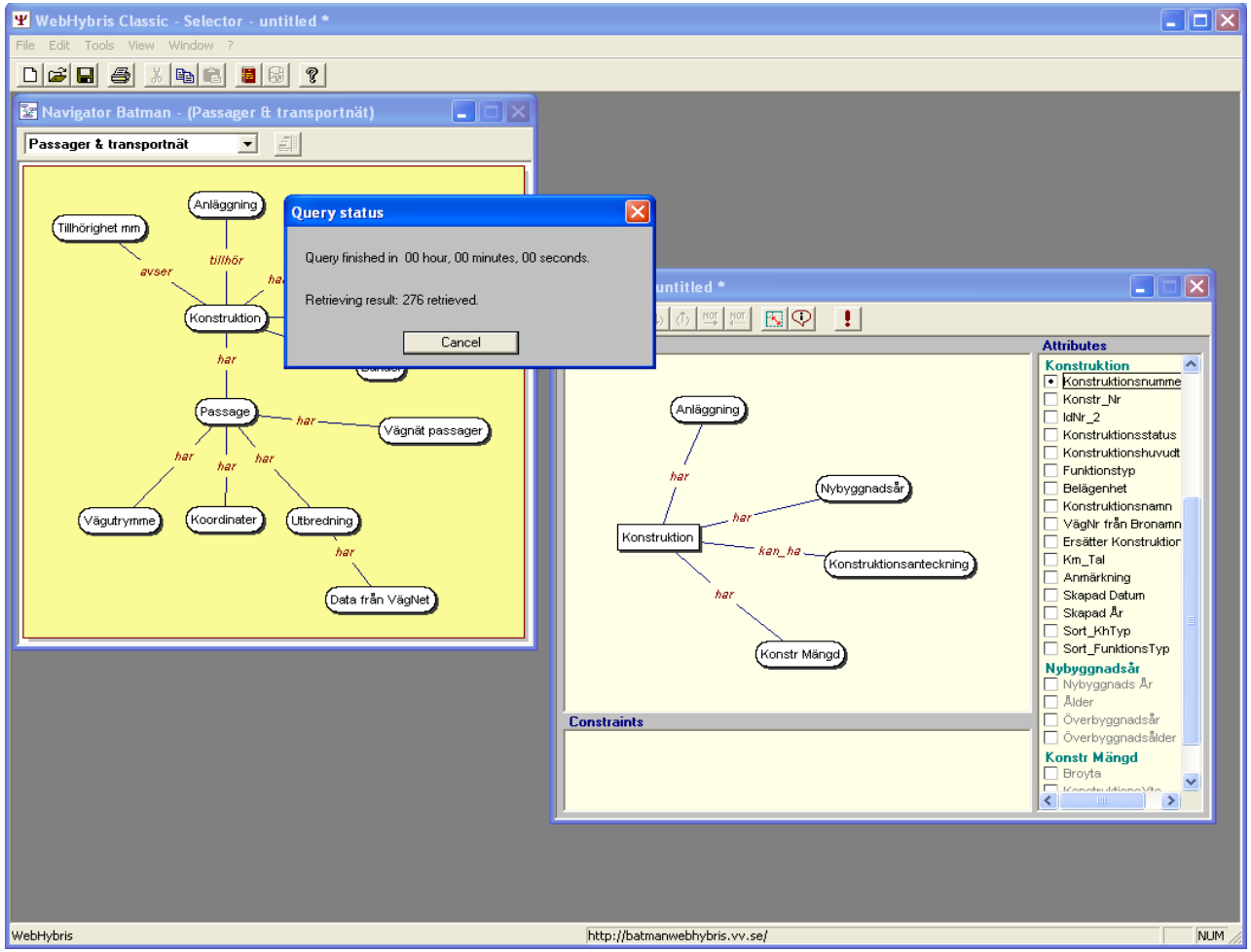
- The time value of money, discount rate
- Life-Cycle Costing/**L**ife-**C**ycle **C**ost **A**nalysis (LCCA)
- **L**ife-**C**ycle **A**ssessment (LCA)
- The concept of the lowest proposal & the concept of least LCC proposal

The Swedish Bridge and Tunnel Management System "BaTMan"



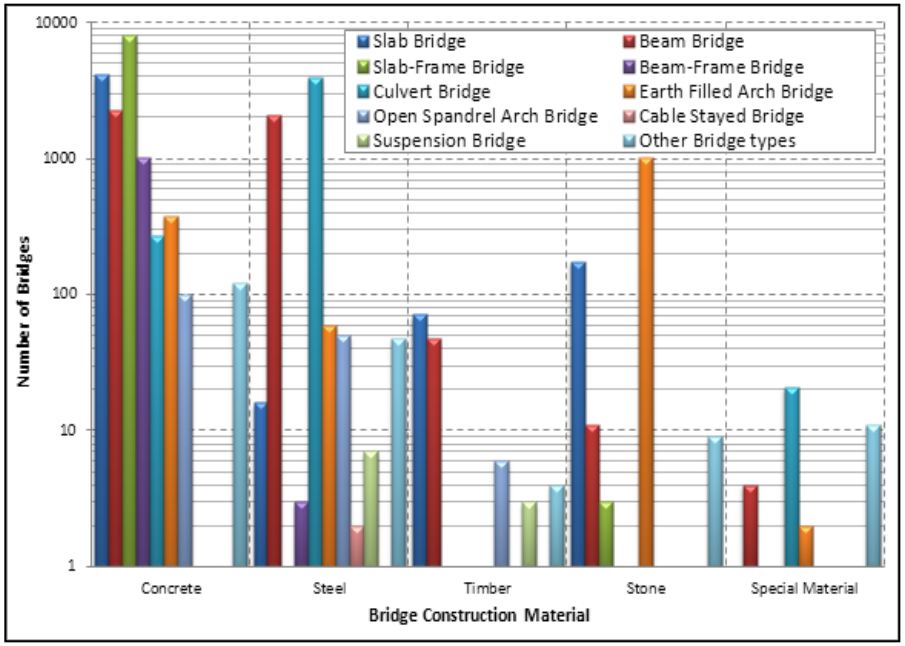
https://batman.vv.se/batman/

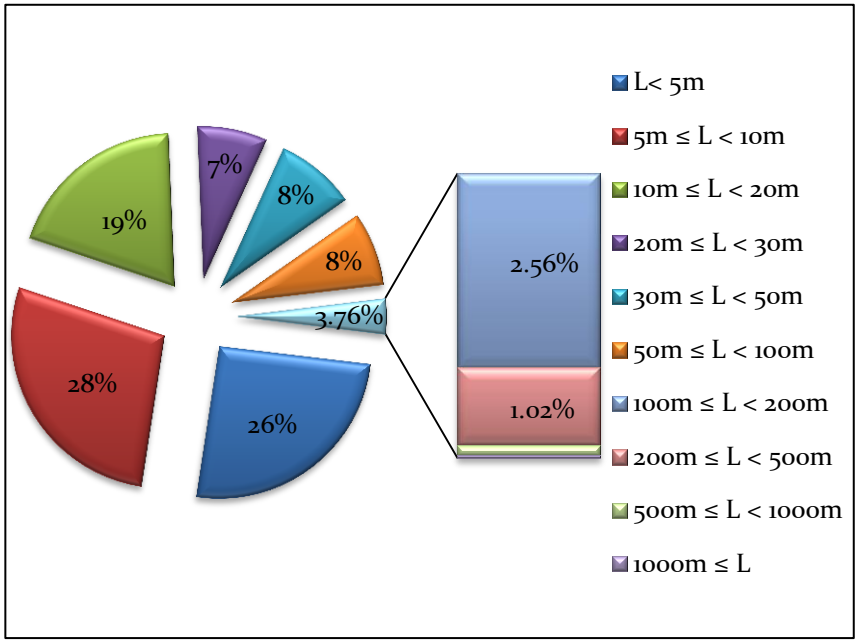
BaTMan’s Navigation Tool (WebHybris)



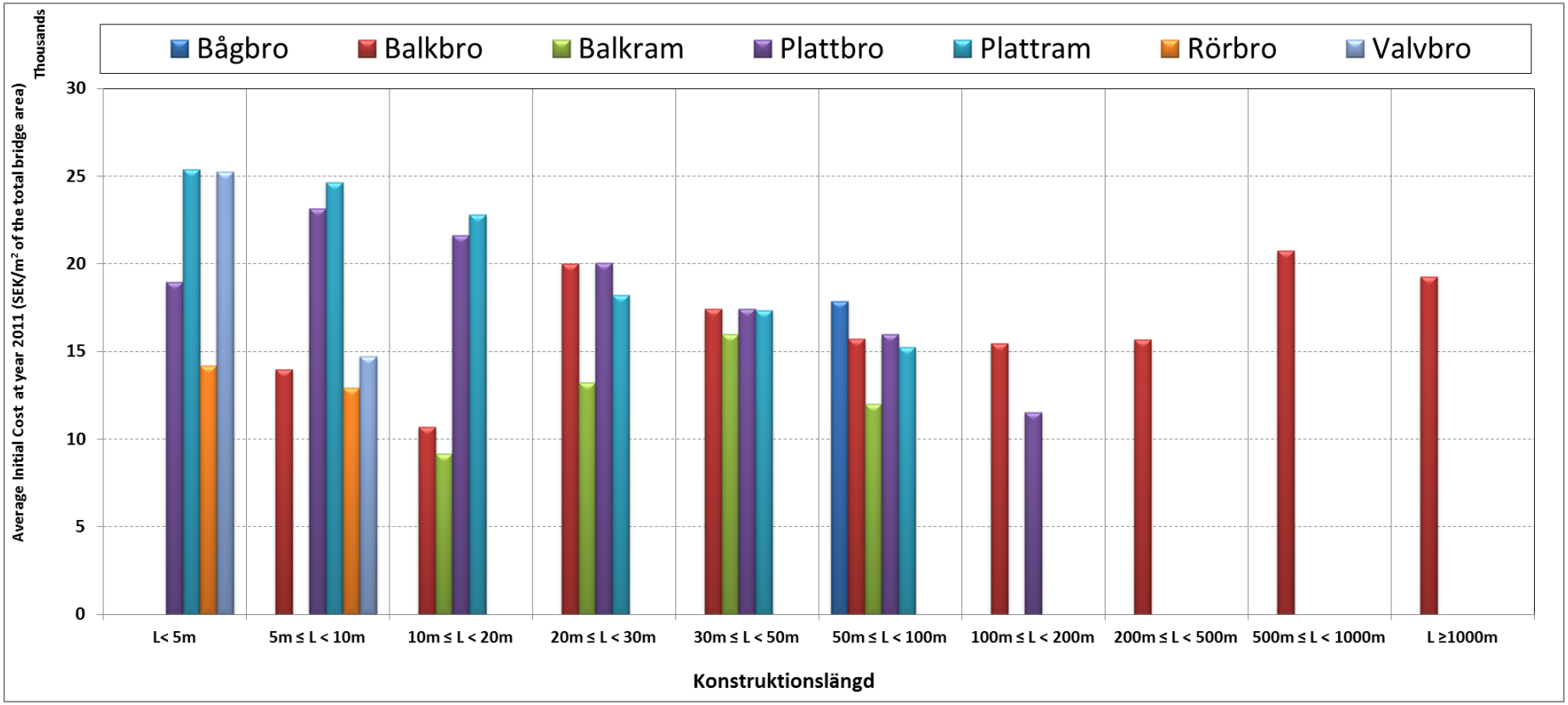
The Swedish Bridge Stock 2011

	Bridge Function Type				Total No. Of Bridges	Bridge Total Area (m^2)	Bridge Total Length (m)
	Roadway	Railway	Pedestrian & Bicycle	Other			
BaTMan's Bridges	23,848	4,411	1,619	251	**30,129**	7,644,208	668,381
Trafikverket's Bridges in BaTMan	20,050	3,179	207	14	**23,450**	5,858,570	528,905



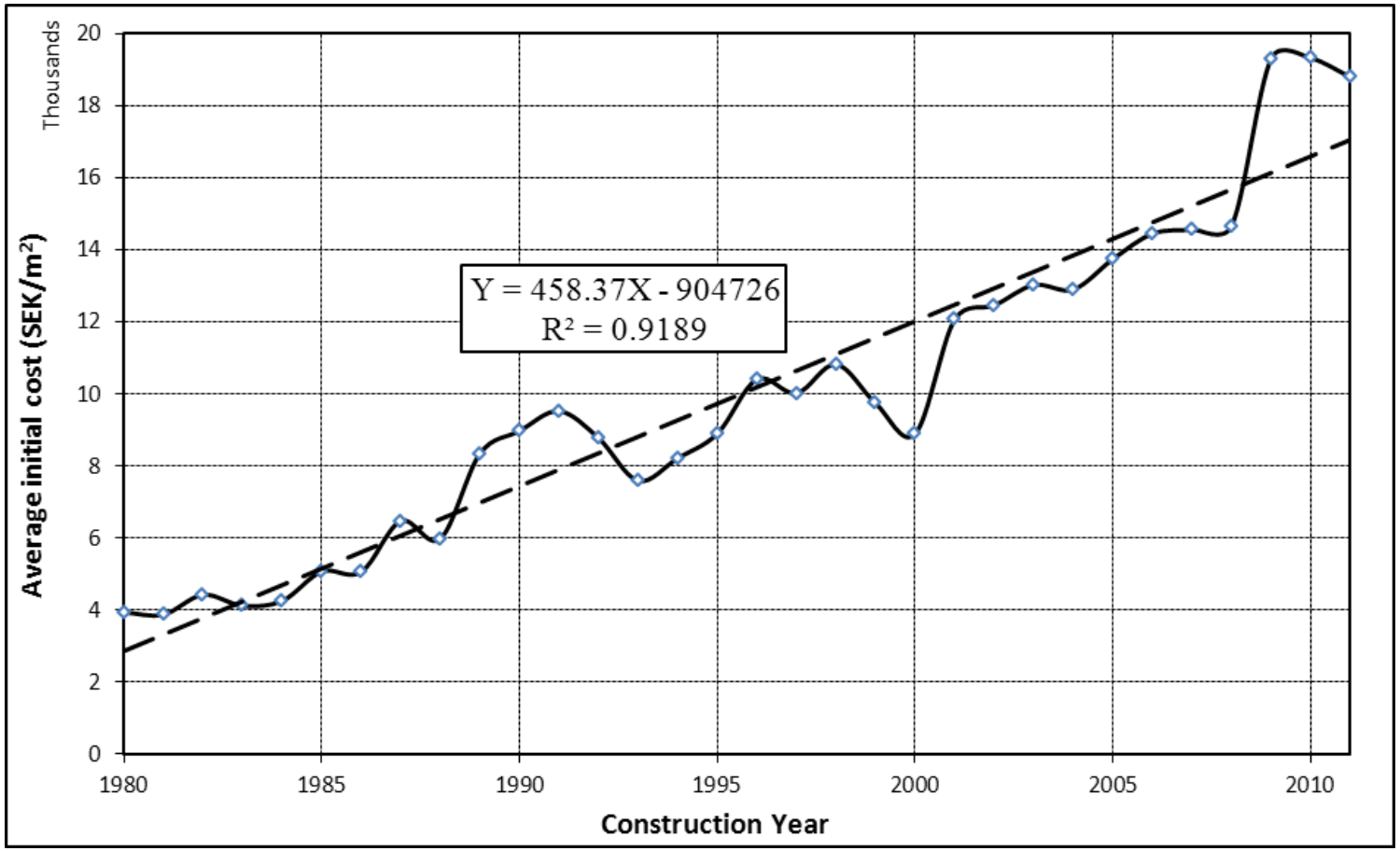


Swedish Bridges Real INV Cost



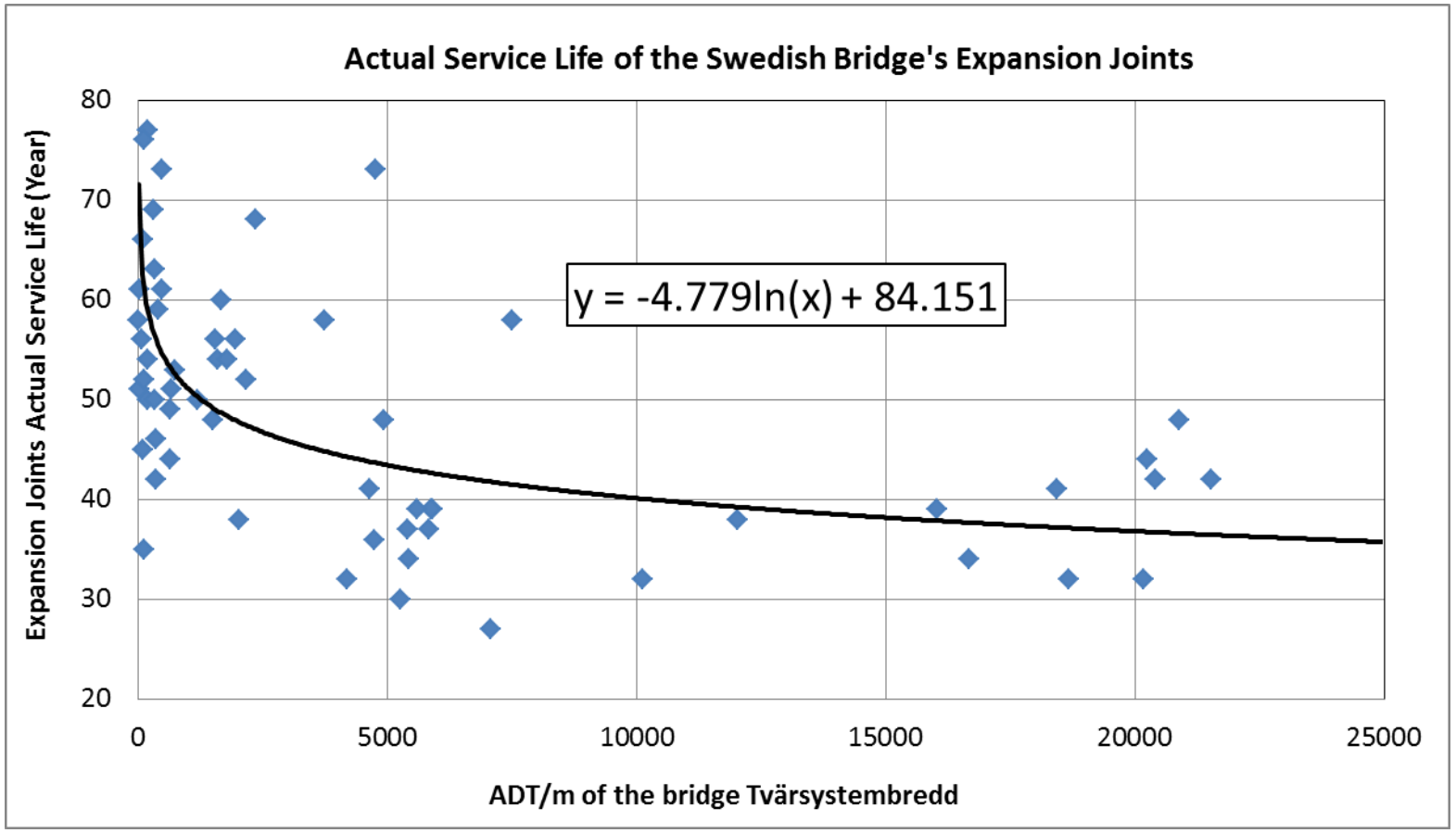
The average real initial costs of the Swedish bridges different types, based on cost data for 2,508 bridges constructed between 1980 and 2011.

Swedish Bridges Anticipated INV Cost



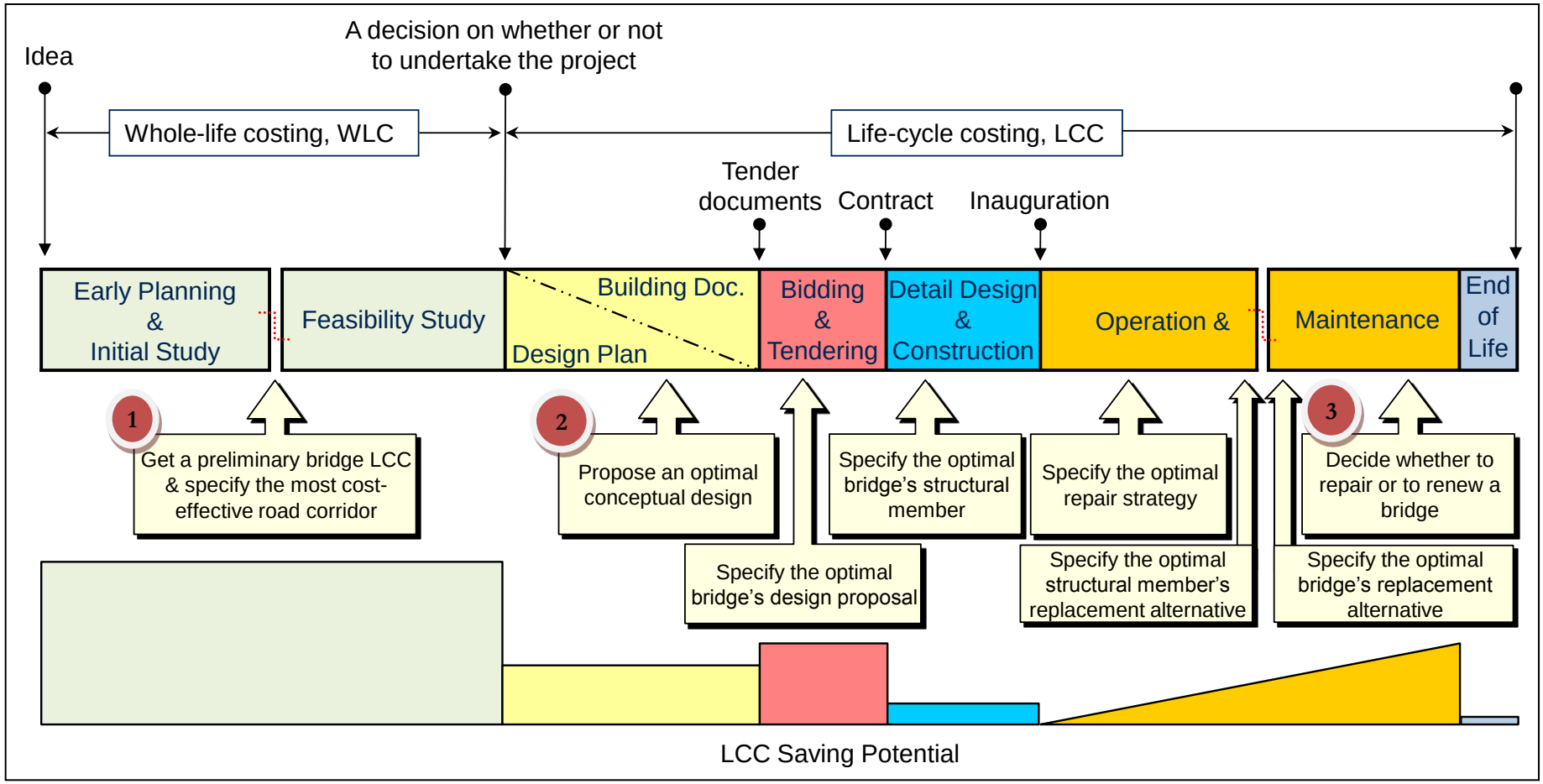
The inflation rate for the Swedish bridges initial costs

Structural-Members Life-Cycle Measures

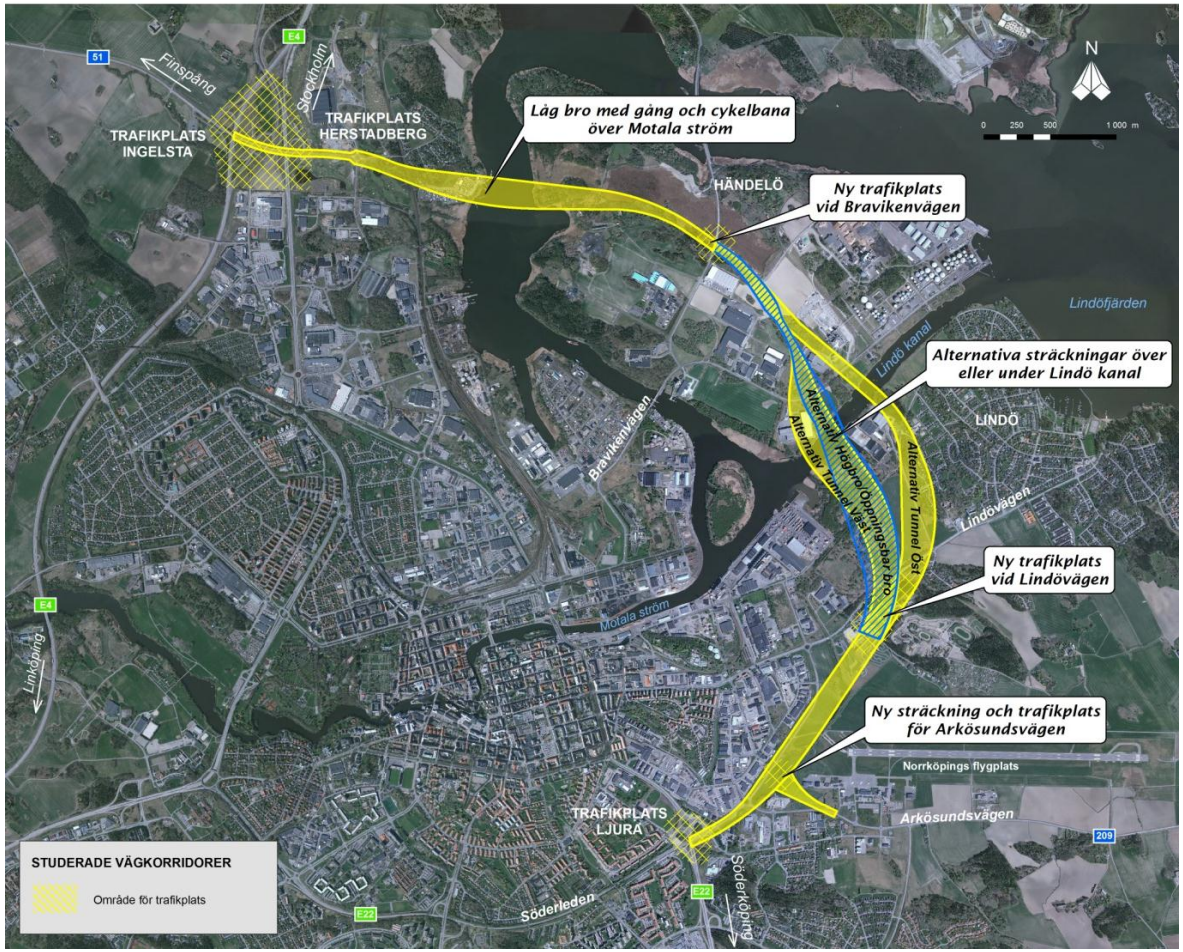


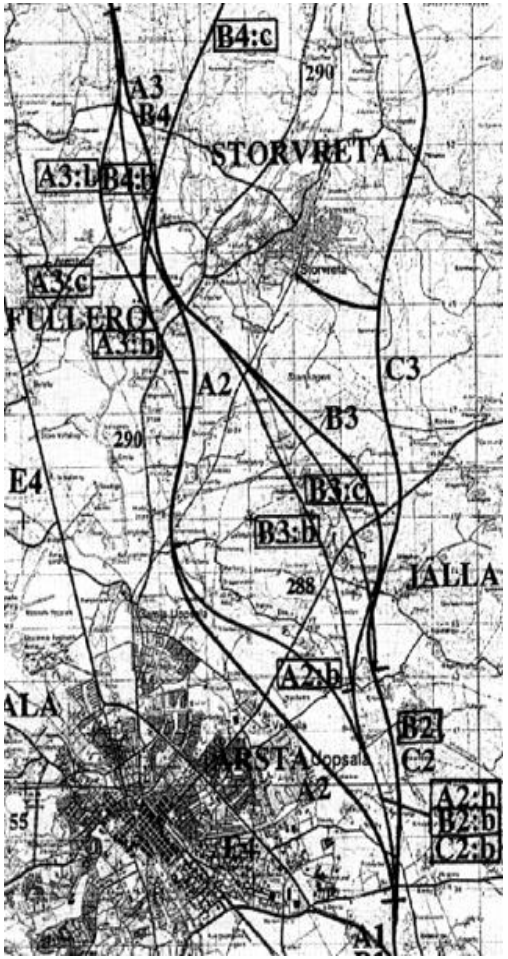
Based on 288 Replacement Actions performed between 1979 and 2010

Bridge Life and the possible LCCA App.

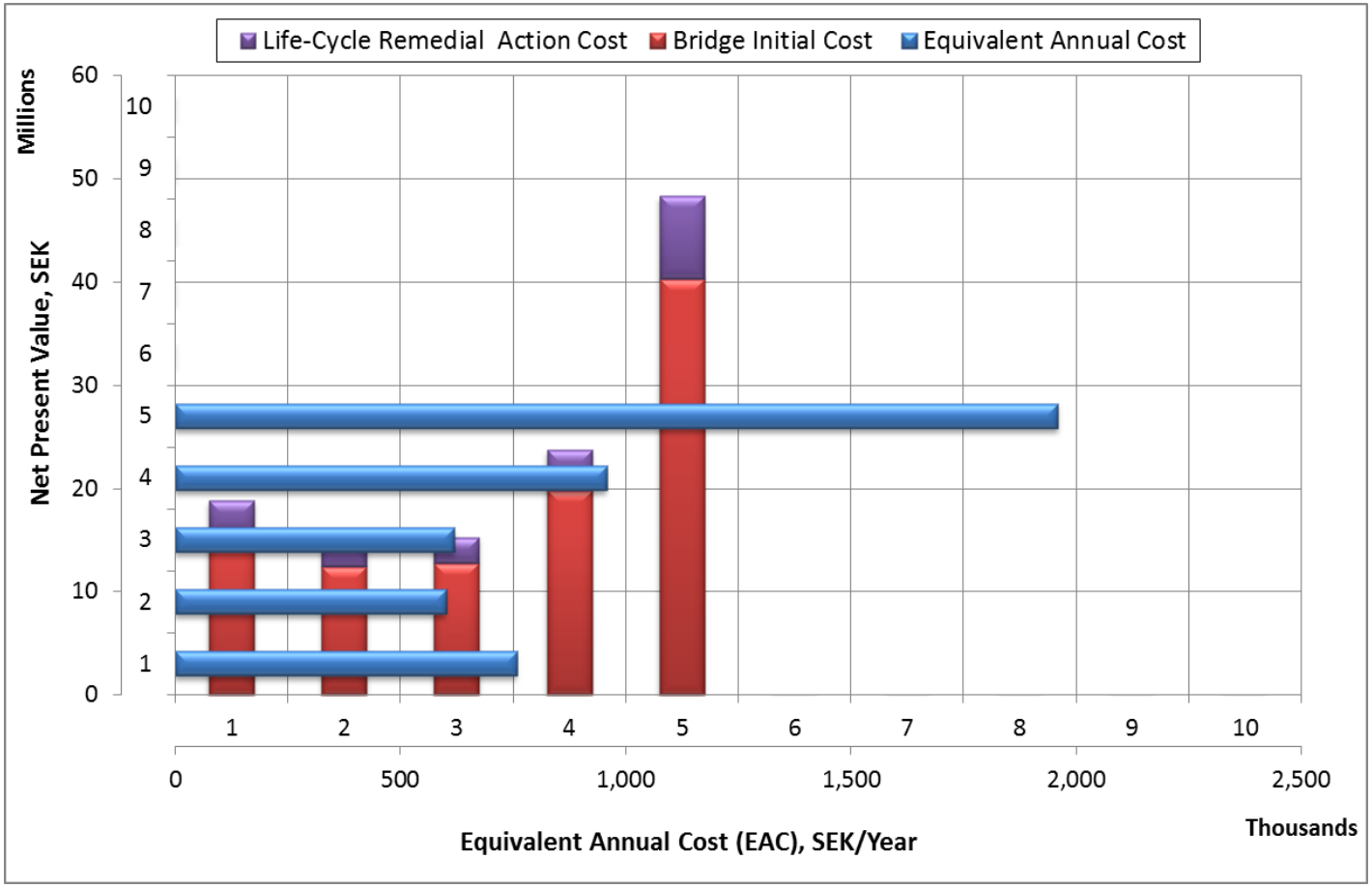


App. No. (1): Specify the most life-cycle cost-effective road corridor

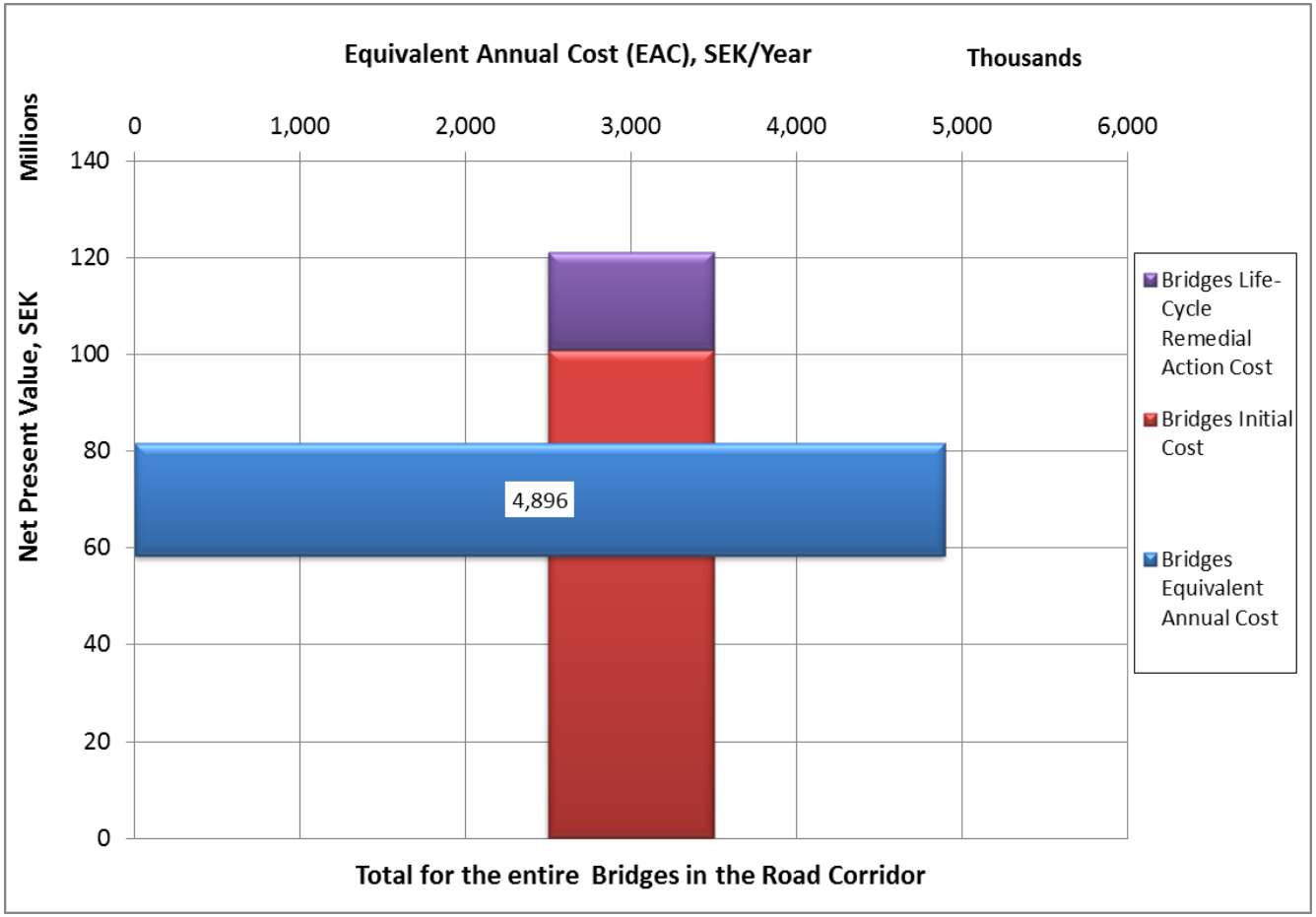




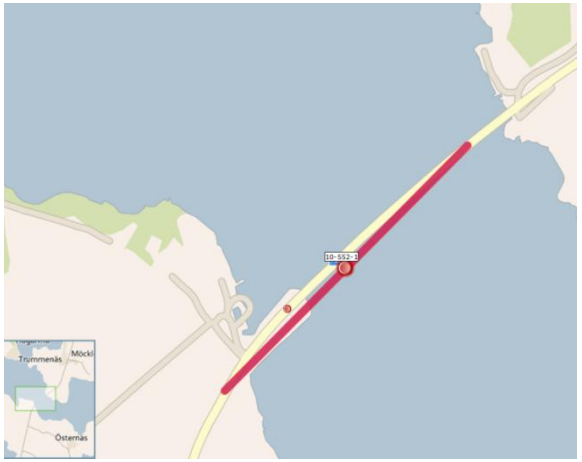
App. No. (2): Specify the most life-cycle cost-effective road corridor

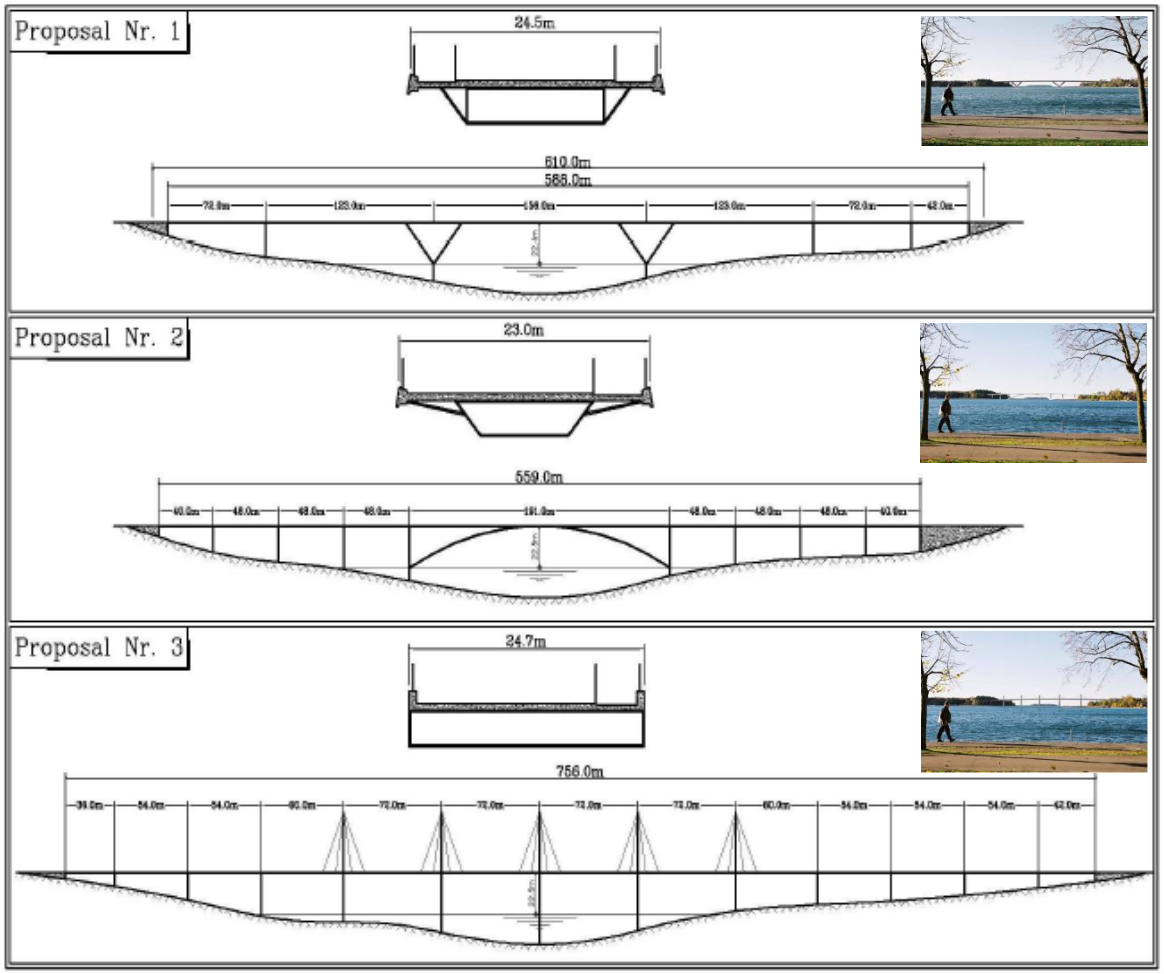


App. No. (2): Specify the most life-cycle cost-effective road corridor

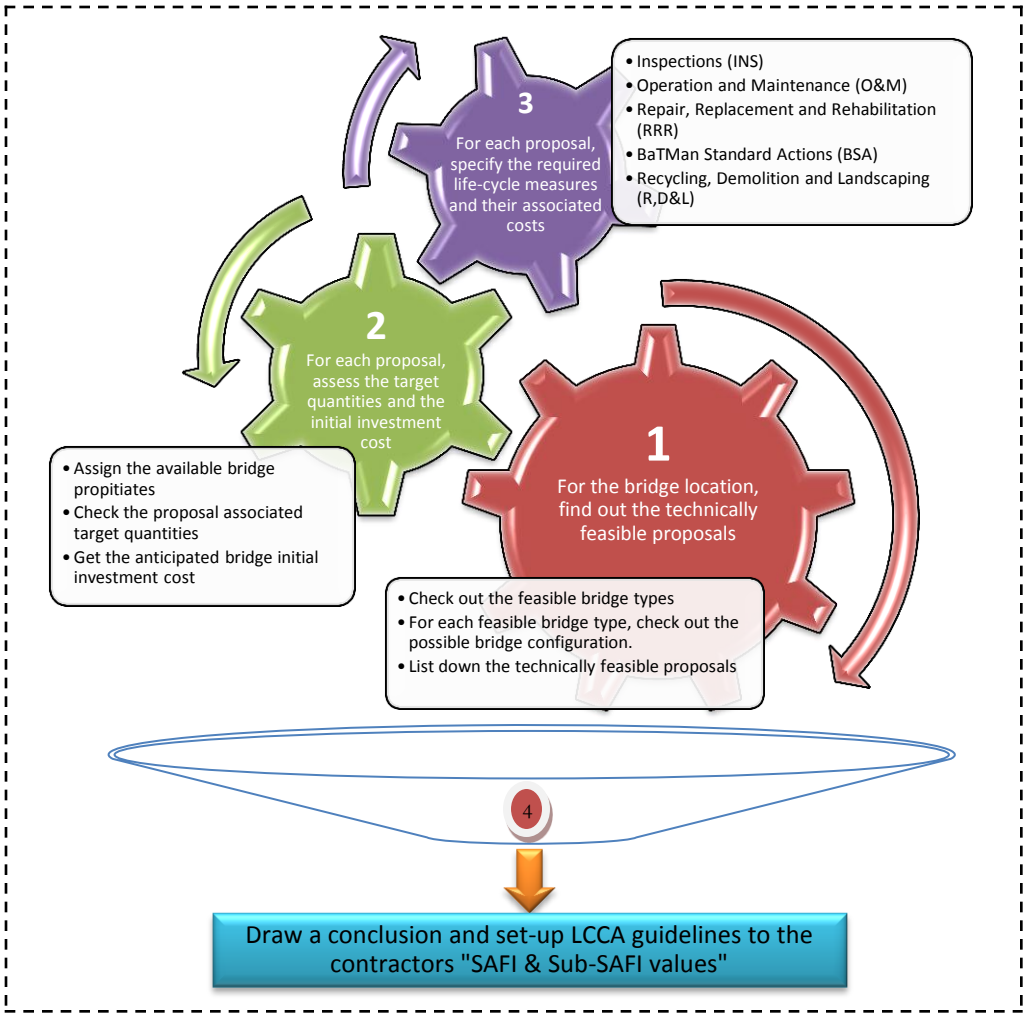


App. No. (2): **Propose an optimal conceptual design during**

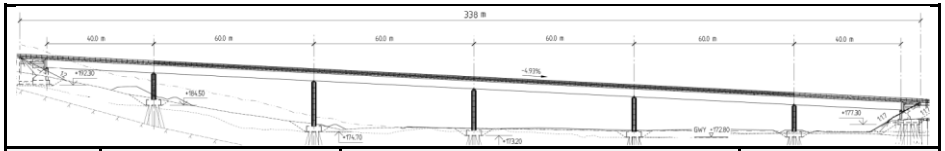


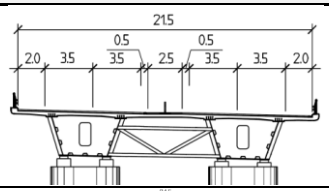
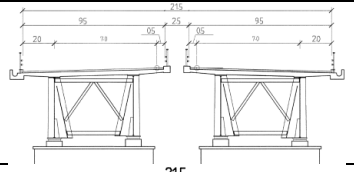
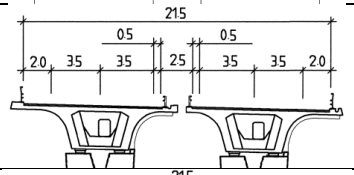
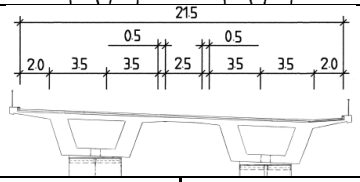
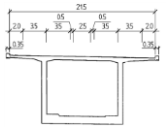


App. No. (2): Analysis Steps

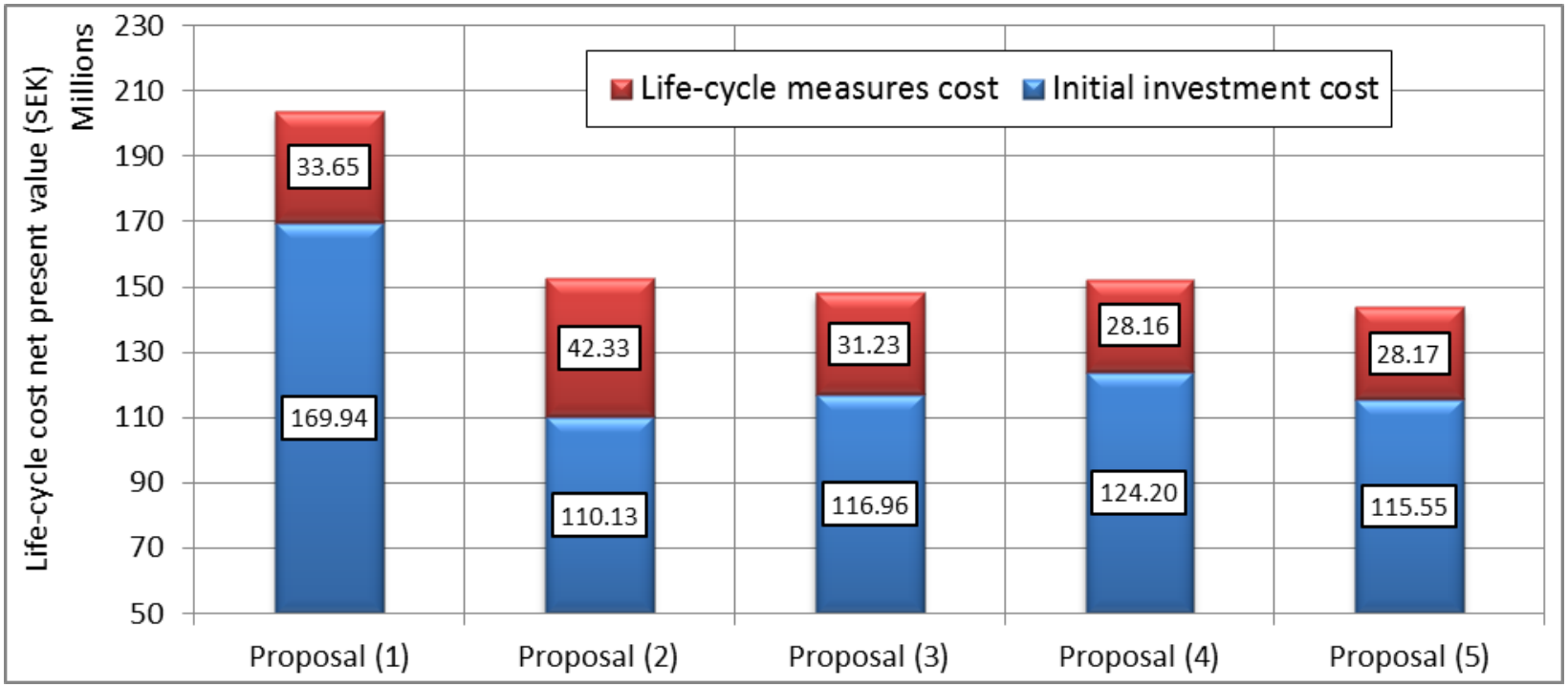


Case-Study (1): The Karlsnäs Bridge



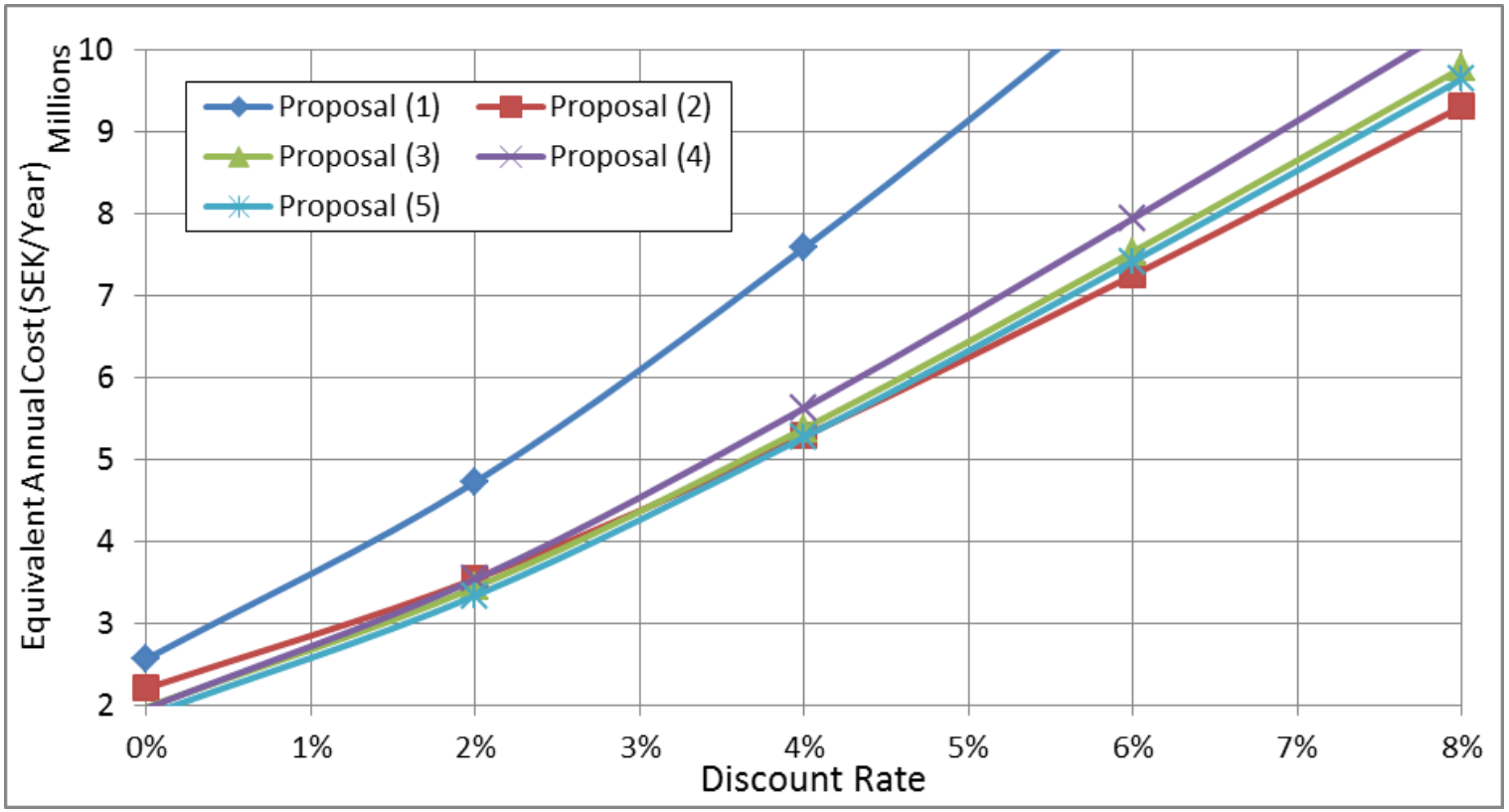
Proposal No.	Description	Cross-Section Details	Remarks
1	One bridge, two steel boxes		5 Spans 4X60m + 2X40m Superstructure depth: 2.3m
2	Two Bridges, two steel I beams per bridge		5 Spans 4X60m + 2X40m Superstructure depth: Haunch beam Max. 3.2m Min. 1.8m
3	Two bridges, one pre-stressed concrete box per bridge		7 Spans 5X50m + 2X35m Superstructure depth: Haunch beam Max. 2.8m Min. 1.6m
4	One bridge, two pre-stressed concrete boxes.		7 Spans 5X50m + 2X35m Superstructure depth: Haunch beam Max. 2.8m Min. 1.6m
5	One bridge, one integral-cantilever concrete box	 	4 Spans 2X100m + 2X60m Superstructure depth: Haunch beam Max. 6.5m Min. 2.3m

LCCA Results



- At discount rate equal to 4 %, the most cost-effective proposal is proposal (5) and the least cost-effective proposal is proposal (1).
- The Net Saving in case of implementing proposal (5) in comparison of implementing proposal (1) is equal to **56.7 Million SEK**.

Sensitivity Analysis



Regardless of the discount rate, proposal (1) is the lease cost-effective proposal which is associated with the highest equivalent annual cost.

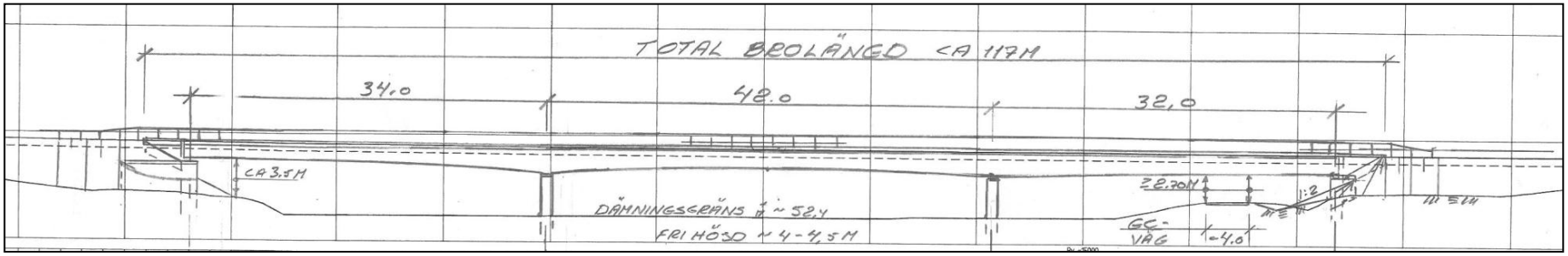
LCCA Guidelines in the Tender Documents SAFI-Proposal Level

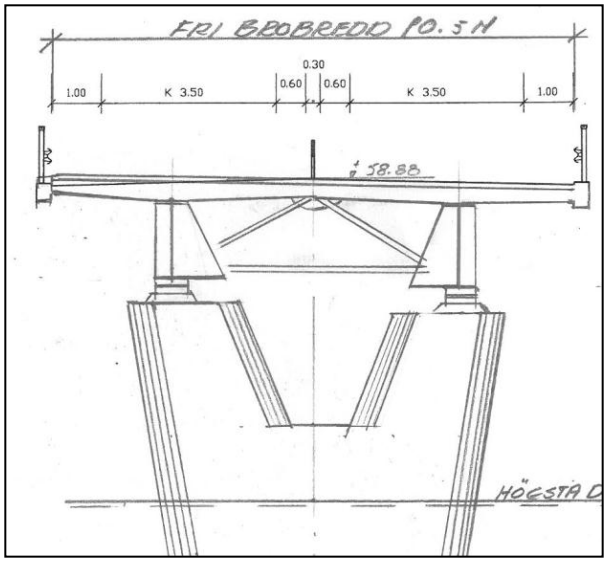
LCCA Guidelines in the Tender Documents					
Proposal No.	1	2	3	4	5
Anticipated INV Cost (M SEK)	169.94	110.13	116.96	124.20	115.55
LCM Cost NPV (M SEK)	15.86	19.33	14.79	13.61	13.58
Total LCC NPV (M SEK)	185.79	129.46	131.75	137.80	129.13
Cost-effectiveness Rank	Worst	Second best	Third best	Fourth best	Best
SAFI (K SEK), Bridge-Owner	**2,272**	**5,750**	**1,210**	**22**	**0**
During the Bid Evaluation Process					
INV Cost (M SEK)	163.6	124.8	121.6	145.6	--
Total LCC NPV (M SEK)	165.87	130.55	122.81	145.62	--
Cost-effectiveness Rank	Worst	Second best	Best	Third Best	--

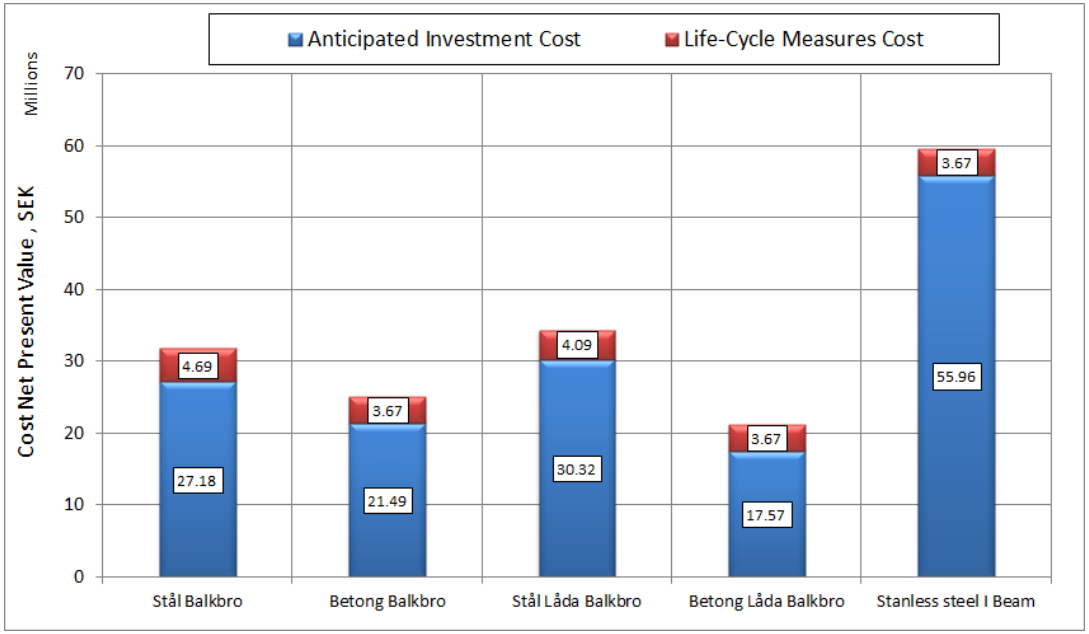
LCCA Guidelines in the Tender Documents SAFI-Structural Member Level

Target Part	Unit	Free BQ	Sub-SAFI		Proposal (1)		Proposal (6)		
			Unit LCM cost (K SEK/Unit)	Fixed Cost (K SEK)	Variation	Sub-SAFI Sub-total (K SEK)	Target quantities	Variation	Sub-SAFI Sub-total (K SEK)
Bearings number	set	6	**7.01**	54.42	22	154	14	8	56
Drainage system points	set	5	**32.67**	0	2	65	7	2	65
Edge beam length	m	676	**1.62**	108.30	0	0	676	0	0
Expansion joint length	m	89	**5.78**	156.37	-45	-258	45	-45	-258
Painted area	m^2	0	**0.35**	85.29	6,315	2,310	6,315	6,315	2,310
Parapets length	m	676	**0.99**	0	0	0	676	0	0
Paved area	m^2	7,267	**0.53**	462	0	0	7,267	0	0
Slops and cons area	m^2	2,141	**0.38**	0	0	0	2,141	0	0
Superstructure area	m^2	7,176	**0.14**	0	0	0	7,176	0	0
Total bridge area	m^2	7,537	**0.62**	0	0	0	7,537	0	0
SAFI (K SEK), Contractor					**2,272**		**2,174**		

Case-Study (2): The Kolbäcksån Bridge







Comparing proposal No. 1 with 4, Trafikverket can save 10.6 Million SEK.

Large-Scale Feasibility

- Based on both case studies: The average net saving is equal to 8384 SEK/m^2.
- It can roughly be said that Trafikverket is expected in the coming ten years to annually build an average bridge total area of 55000 m^2 that are equivalent to of 200 bridges.
- Consider that 50 % of the Trafikverket's new bridges might be subjected to a wrong decision.
- This means that Trafikverket can annually save **230 million** SEK. This annual loss is 220 million SEK as initial investment cost and 10 million SEK as LCM cost.

App. No. (3): Repair or Replace a Bridge?

Paper I: Struc. & Infrastructure Eng. J.
[6-367-1] Bro över Lillån
Construction Year: 1934

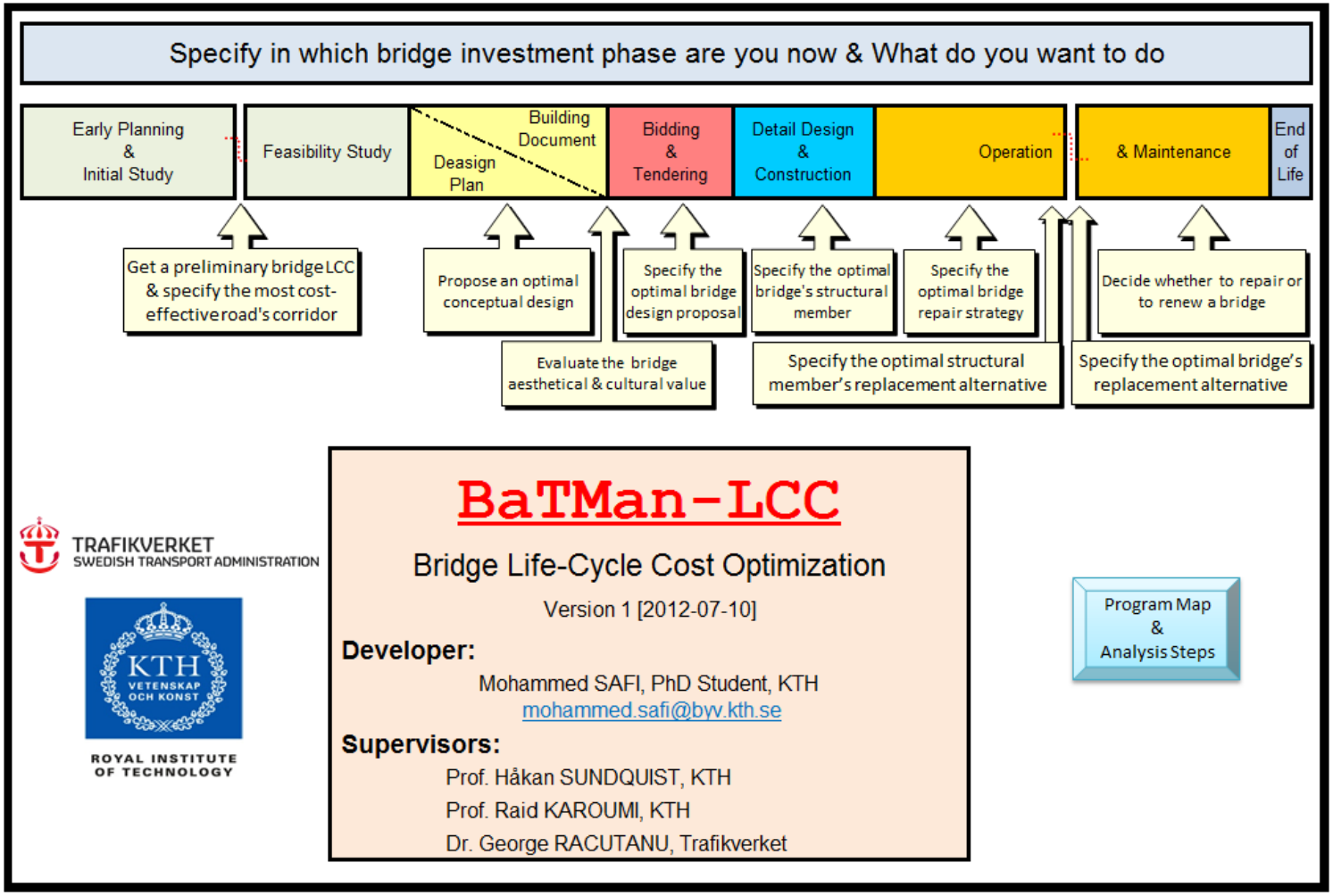
Paper II: TRR Journal
[18-352-1] Bro över Täbyån, Höjen
Construction Year: 1929

(Residual service life is not more than three years, if no action is taken CC2)

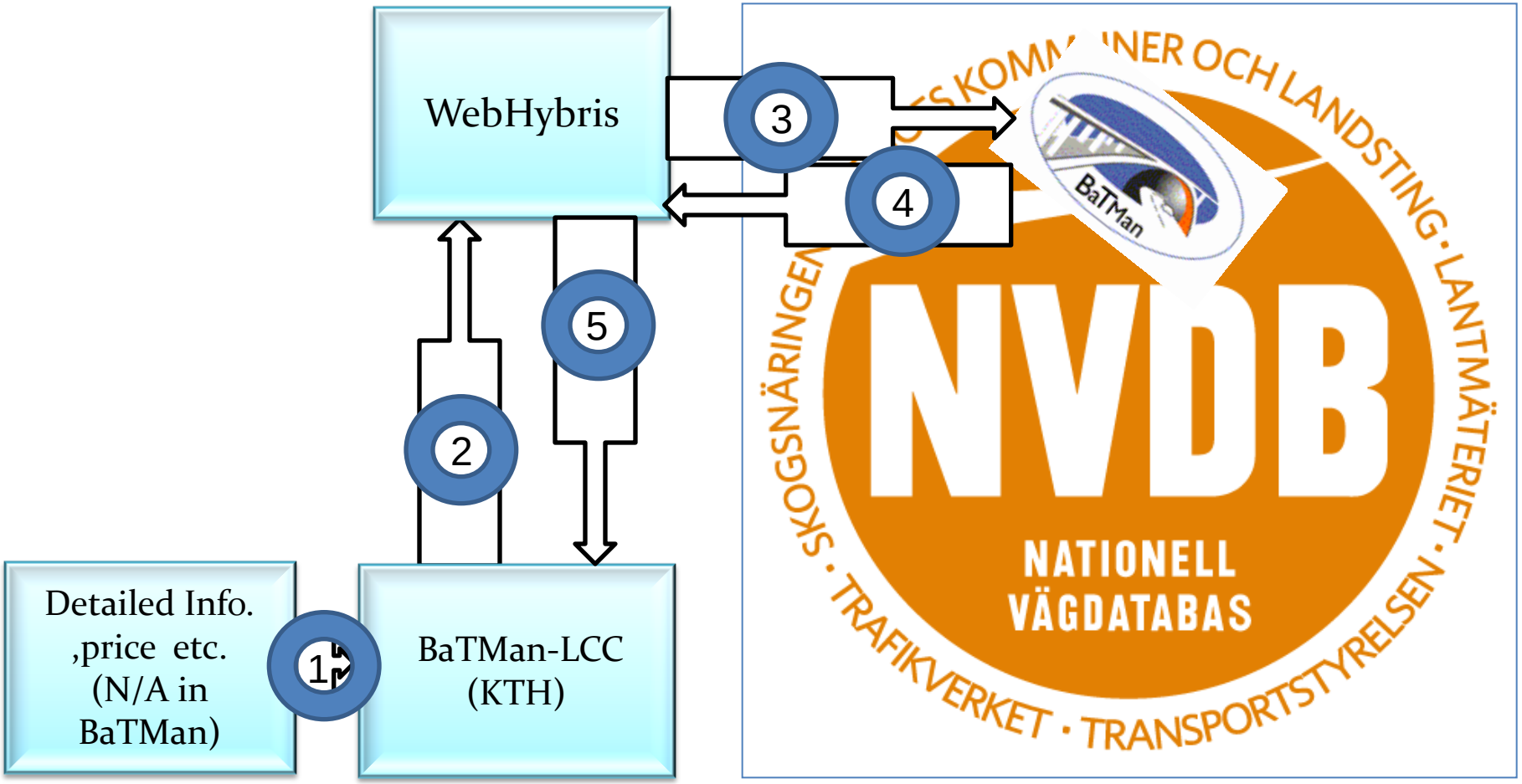
Large-Scale Feasibility

- The bridges should not be repaired and should be replaced after utilizing their residual service life.
- The analysis shows that, the opportunity loss is equal to 241 SEK/year/m^2
- Trafikverket is responsible for:
  - 23,948 bridges with a total bridge area of 5,516,590 m^2
  - 6,268 bridges older than 70 years, total bridge area of 619,944 m^2.
- Consider that 50% of the Trafikverket's old bridges might be subjected to wrong decision, This means:
  - Trafikverket can save 74.7 million SEK each year
- This loss will stand for 20 year, this also means:
  - Trafikverket can save 1.49 billion SEK during the coming 20 years

BaTMan-LCC Program

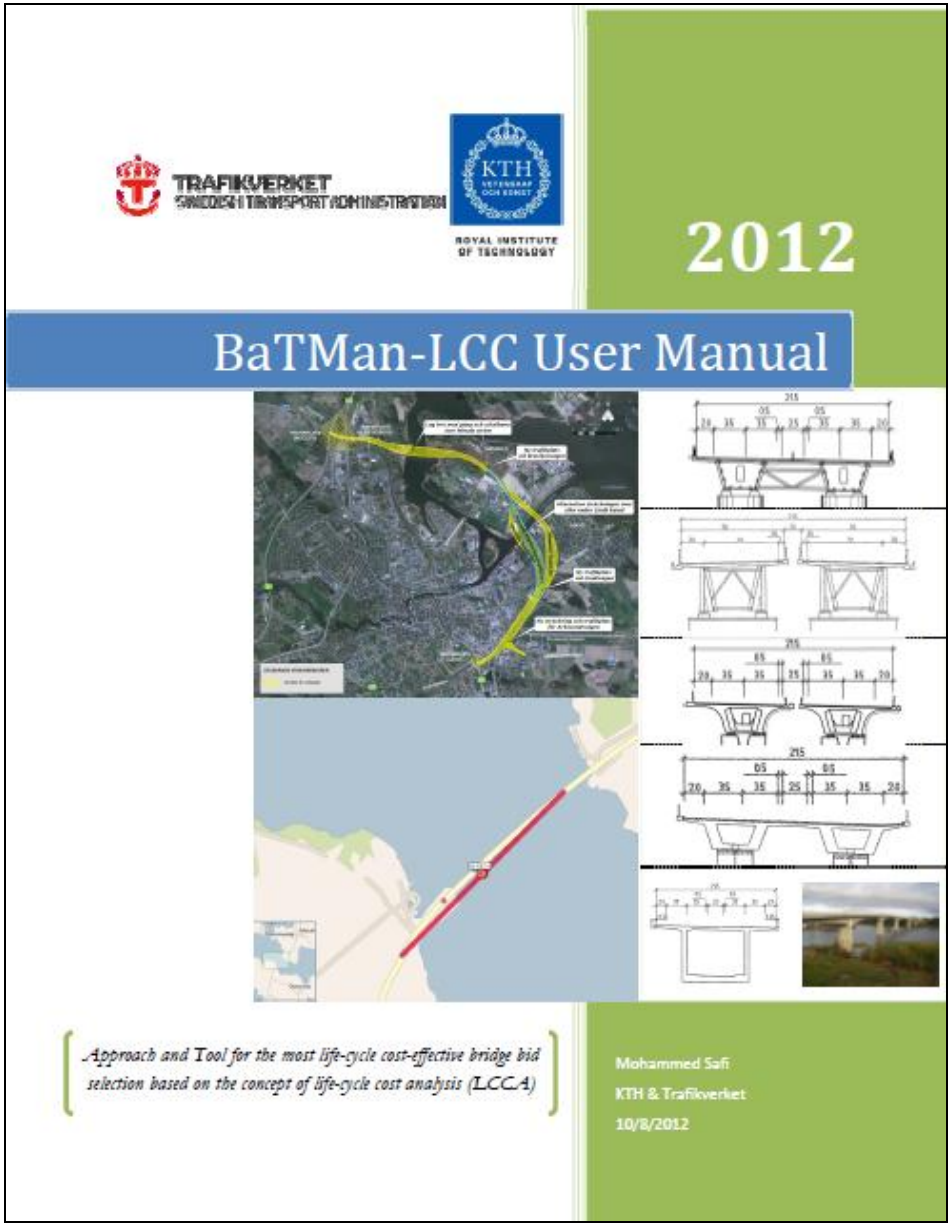


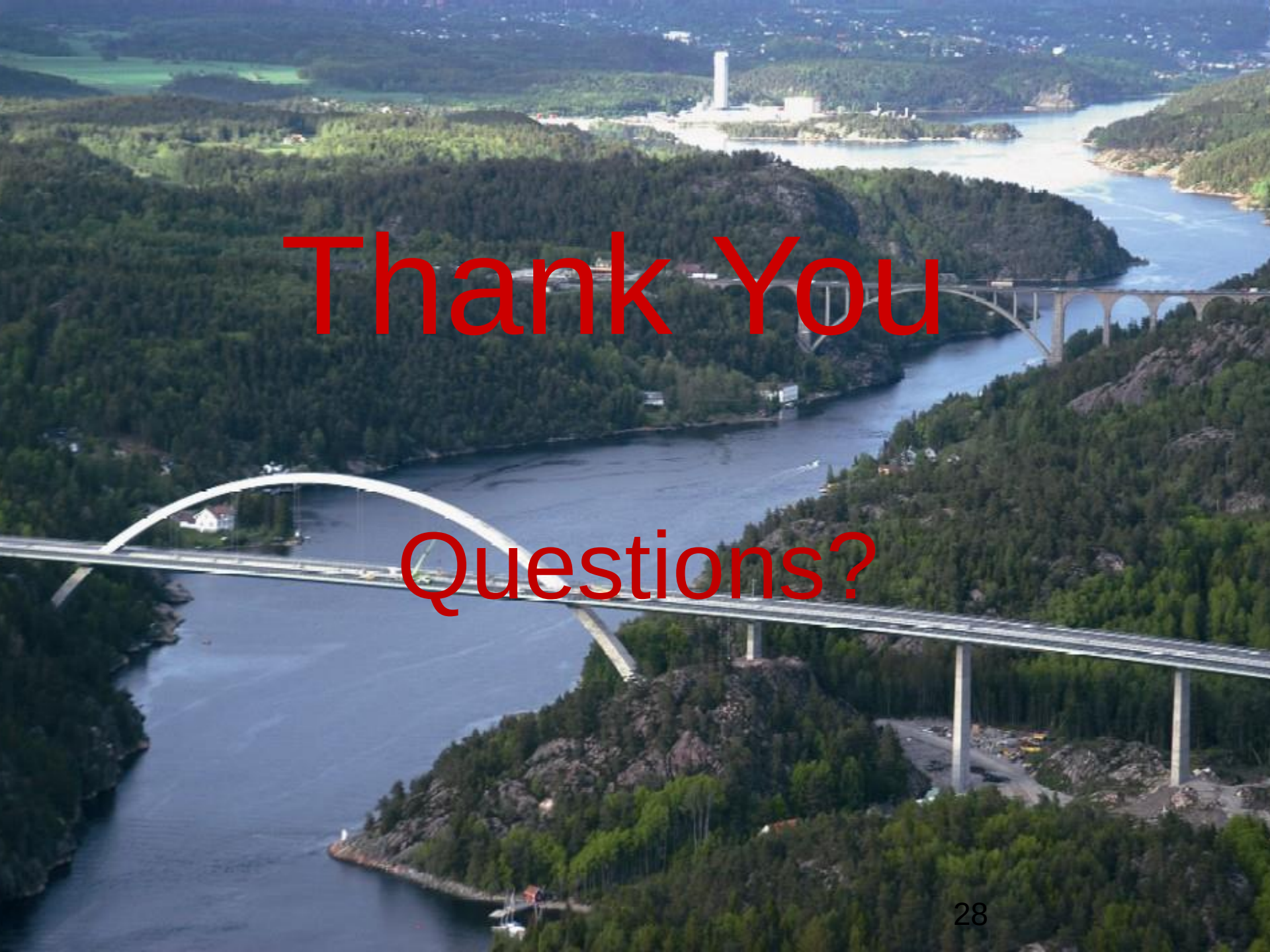
BaTMan-LCC relation with BaTMan



BaTMan-LCC Course

- **Course Coordinators:**
  - Peter Simonsson
  - Mohammed Safi
  - George Racutanu
- **7 Super-Users**
- **Course Outlines**
  - **Frist Session:**
    - November 12, 2012
    - November 13, 2012
    - November 14 , 2012
  - **Second Session:**
    - December 4, 2012
    - December 5, 2012
    - December 6, 2012
  - **Summing Up day 2013**




Thank You
Questions?