

1. Introduction to the Developed Software

A computer software is developed in Visual Studio (version 2010) [62] using Vb.net programming language to perform the analysis, design and cost optimization of prestressed U-shaped girder. The general tab, dimension tab and initial design tab of developed software is shown in **Figure S1** through **Figure S4** respectively and can be found in the appendix section. In the general tab and dimension tab there are text boxes for material properties, initial design variables and for explicit constraints limits. In the initial design tab, analysis and design checks are performed for initial design in order to start optimization process efficiently. Also the optimum results after successful iteration in a program is shown in **Figure S5**.

The screenshot displays the 'General' tab of the U_TUB software. It features input fields for material properties, prestressing strands, and reinforcement. The cross-section diagram shows a U-shaped girder with dimensions labeled X1 through X7.

Category	Property	Value	Unit
Concrete	f_c'	45	MPa
	f_{ci}	35	MPa
Prestressing strands	dia	15.24	MPa
	Unit Area	140	MPa
	E_p	196500	MPa
	f_{pu}	1860	MPa
Reinforcement	f_y	420	MPa
	E_s	200000	MPa

The cross-section diagram shows a U-shaped girder with dimensions labeled X1 through X7. X1 is the top flange width, X2 is the top flange thickness, X3 is the web thickness, X4 is the web height, X5 is the bottom flange width, X6 is the bottom flange thickness, and X7 is the bottom flange height.

Figure S1. General view of developed software.

U_TUB

General Dimensions Initial Design Unit Cost Optimum Cost and variables Top flexure stress at transfer vs Iteration Bottom flexure stresses Vs Iteration Top flexure stresses at service Vs Iteration Bottom flexure stresses Vs Iteration

Initial design variables		Explicit Constraints	
X1 =	690 mm	550	< X1 > 700
X2 =	345 mm	250	< X2 > 350
X3 =	345 mm	275	< X3 > 350
X4 =	1190 mm	1150	< X4 > 1300
X5 =	440 mm	300	< X5 > 450
X6 =	245 mm	150	< X6 > 250
X7 =	350 mm	275	< X7 > 400
X8 =	34 mm	20	< X8 > 35
X9 =	84 mm	50	< X9 > 85

Where as X8 is the No of steel bars
Where as X9 is the No of Strands

Figure S2. Tab for Initial design variables and explicit constraints.

U_TUB

General Dimensions Initial Design Unit Cost Optimum Cost and variables Top flexure stress at transfer vs Iteration Bottom flexure stresses Vs Iteration Top flexure stresses at service Vs Iteration Bottom flexure stresses Vs Iteration

Analysis Checks

Analysis and results

Top flexure stresses at transfer =		MPa
bottom flexure stresses at transfer =		MPa
Top flexure stresses at service =		MPa
Bottom flexure stresses at service =		MPa
Moment capacity Mn =		N-mm
Shear Capacity Vn =		N

Figure S3. Button for initial design analysis and results.

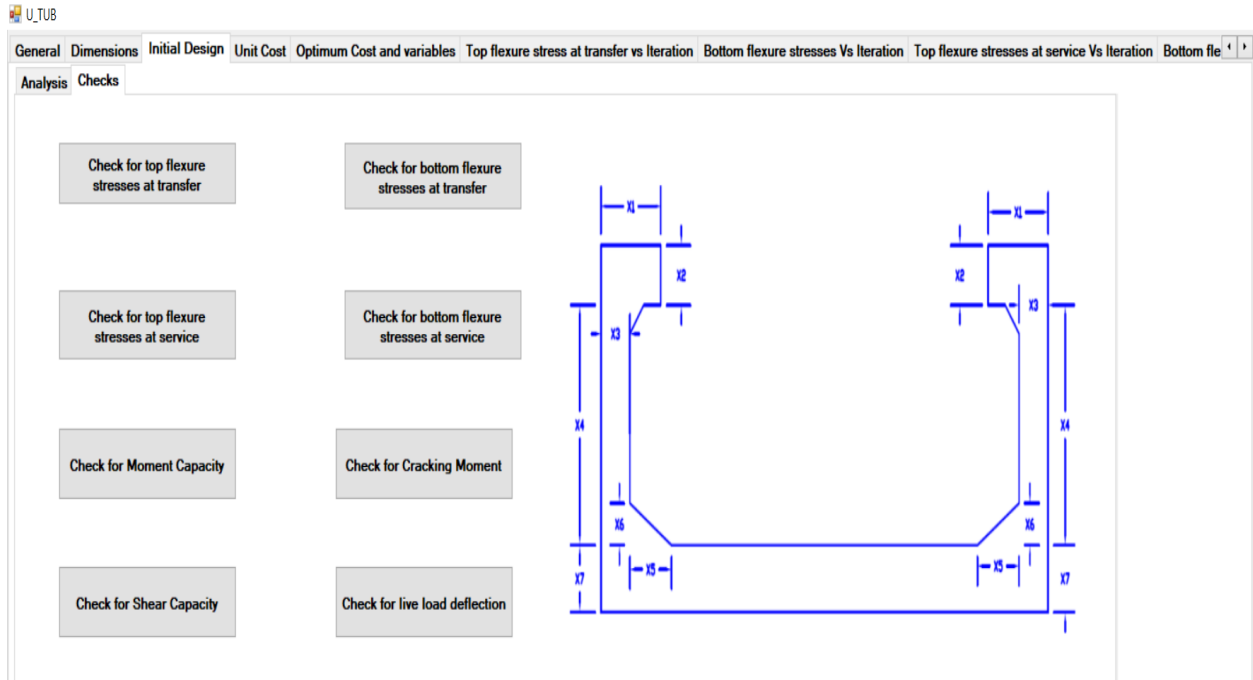


Figure S4. Different buttons for initial design checks.

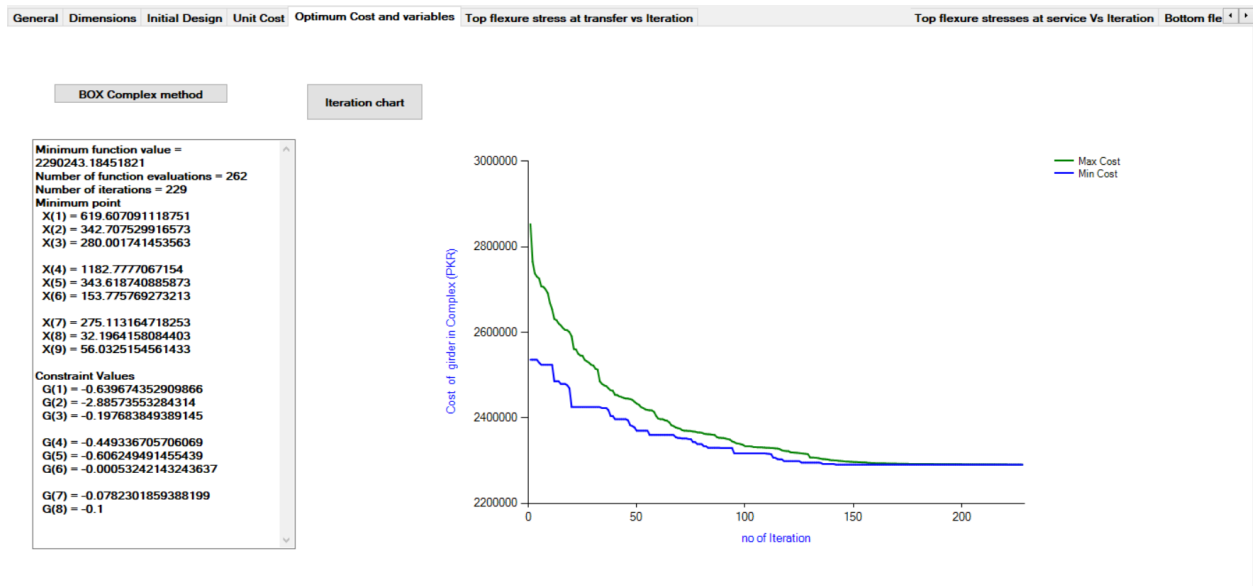


Figure S5. Optimum design result in the developed Software.