



Design of all-solid waste red mud-based cementitious materials based on the simplex centroid method

Purpose:

The purpose of this research paper is to investigate the effect of different proportions of red mud (RM), steel slag (SS), and fly ash (FA) on the unconfined compressive strength (UCS) of cementitious materials using an Enhanced Simplex Centroid Mixture Design.

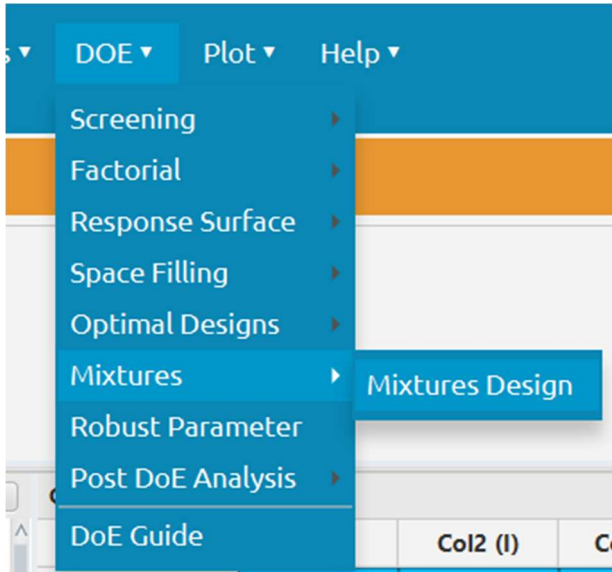
Isalos version used: 2.2.0

Scientific article:

Cui, W. et al. (2024). *Design of all-solid waste red mud-based cementitious materials based on the simplex centroid method*. Construction and Building Materials, 418, 135439.

Step 1: Simplex Centroid Design

In the first tab named "Action", rename it to "Simplex Centroid". Then, go to DOE → Mixtures → Mixtures Design. Select Simplex Centroid, set the number of components to 3, and define the component bounds as A = 0.60–0.80, B = 0.10–0.30, and C = 0.10–0.30. Select Augment the Design with Axial Points and click Execute to generate the 10 experimental mixture points.



DoE Mixtures

?

✕

Number of Replicates

1

Number of Blocks

1

☐ Random Standard order

Select Design

Simplex Centroid

Number of components in the Mixture

3

Augment the Design with Axial Points

☐

Component #

Min

Select Values

Max

A

0.6

0 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.45 0.5 0.55 0.6 0.65 0.7 0.8

0.8

C

0.1

0 0.05 0.1 0.15 0.2 0.25 0.3

0.3

Component #

Min

Select Values

Max

B

0.1

0 0.05 0.1 0.15 0.2 0.25 0.3

0.3

Execute

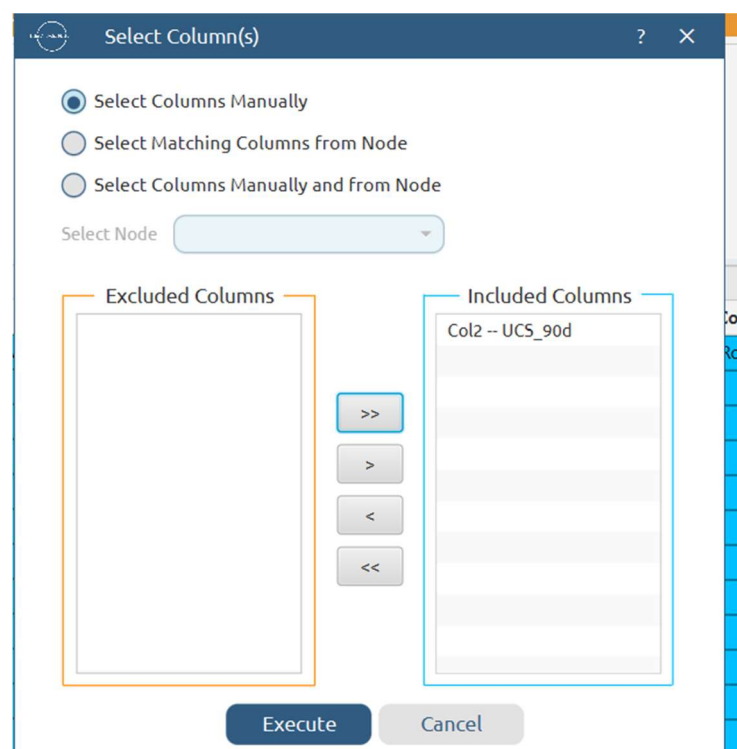
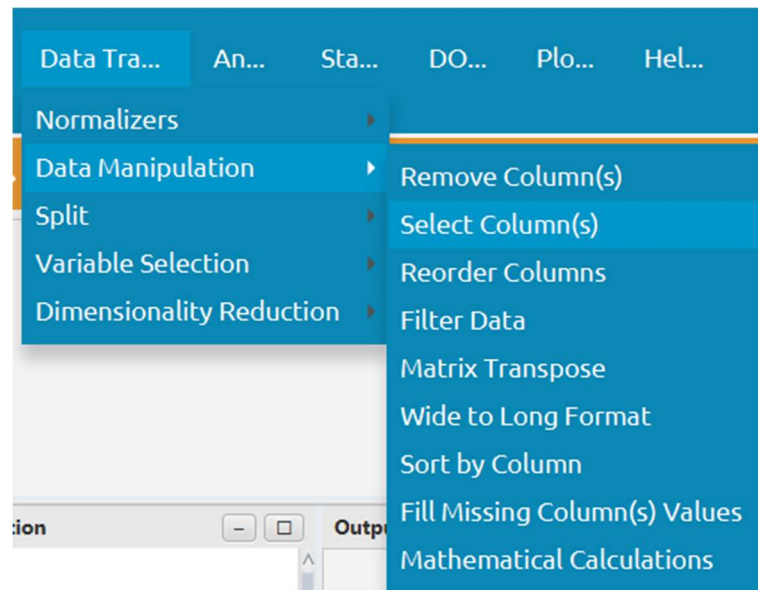
Cancel

Results (right spreadsheet) :

[illegible]

Step 2: Definition of Response Variable

Create a new tab named “Responses”. Define one response column named UCS_90d and enter the 90-day unconfined compressive strength values corresponding to the 10 experimental mixture points. Apply Data Transformation → Data Manipulation → Select Column(s) and include the UCS_90d response column.

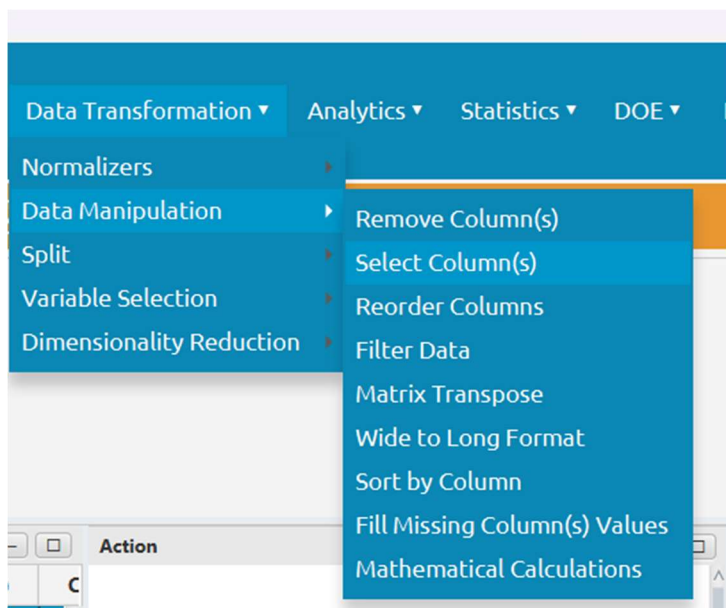
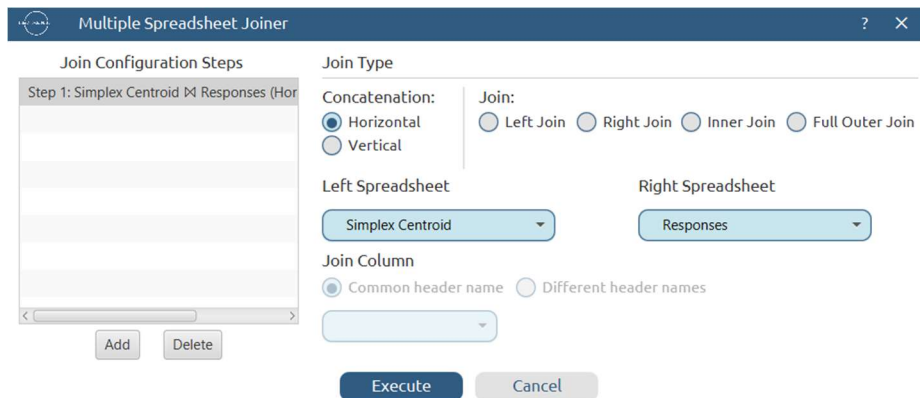
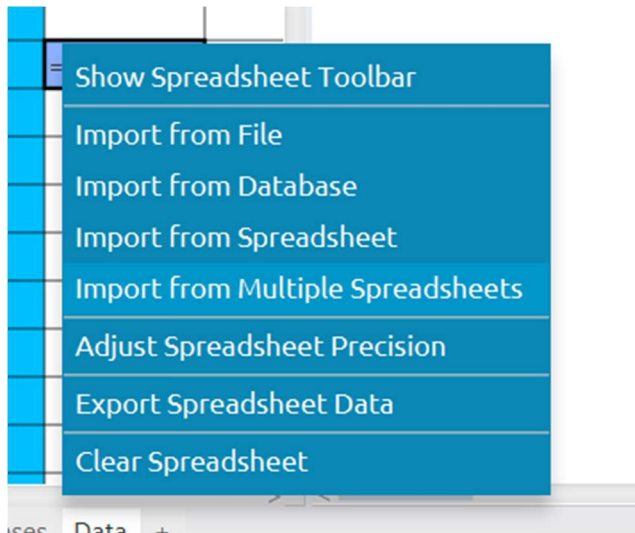


Output				
	Col1	Col2 (D)	Col3	Col
User Header	User Row ID	UCS_90d		
1		5.53		
2		9.97		
3		13.21		
4		6.77		
5		9.99		
6		10.59		
7		9.98		
8		8.33		
9		8.93		
10		10.57		
11				

Step 3: Data Selection

Create a tab named “Data”. To combine the mixture design with the response data, right-click on the spreadsheet and select Import from Multiple Spreadsheets. In the Multiple Spreadsheet Joiner, select Horizontal concatenation, with Simplex Centroid as the Left Spreadsheet and Responses as the Right Spreadsheet. Click Execute to combine the two spreadsheets into a single dataset.

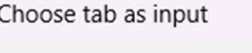
Then, go to Data Transformation → Data Manipulation → Select Column(s). Exclude Standard Order, Block Number, Replicate Number, and Point Type, and include only A, B, C, and UCS_90d. The resulting dataset contains the three mixture components and the corresponding response values.



Step 4: Mixture Analysis – UCS_90d - Linear

Create a new tab named “Regression-UCS_90d”. Right-click on the spreadsheet, select Import from Spreadsheet, choose the Data tab as input, and click Execute.

Then, go to DOE → Post DOE Analysis → Mixture Analysis. Select UCS_90d as the dependent variable, select A, B, and C as the mixture components, and choose Linear as the analysis type. Keep the confidence level at 95% and click Execute to obtain the fitted mixture model and its statistical results.

[illegible]

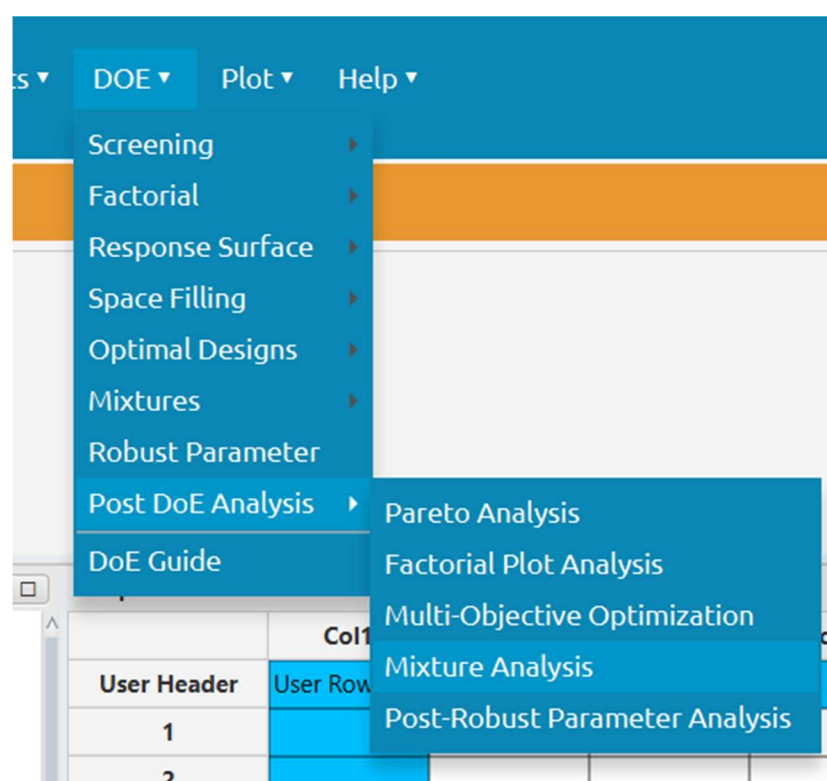
Choose tab as input

Select input tab

Data

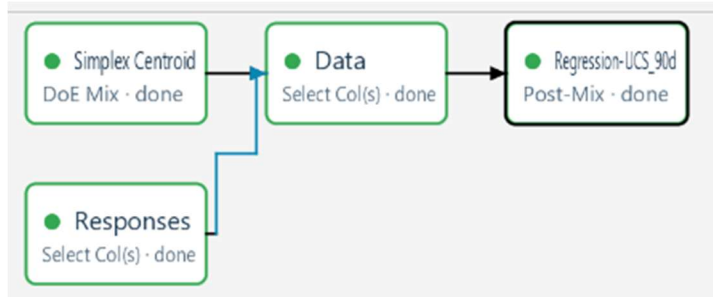
Execute Cancel

Col1	Col2 (D)	Col3 (D)	Col4 (D)	Col5 (D)
User Row ID	A	B	C	UCS_90d
	0.8	0.1	0.1	5.53
	0.6	0.3	0.1	9.97
	0.6	0.1	0.3	13.21
	0.7	0.2	0.1	6.77
	0.7	0.1	0.2	9.99
	0.6	0.2	0.2	10.59
	0.6666667	0.1666667	0.1666667	9.98
	0.7333333	0.1333333	0.1333333	8.33
	0.6333333	0.2333333	0.1333333	8.93
	0.6333333	0.1333333	0.2333333	10.57



Final Isalos Workflow

The final workflow is presented below :



References

Cui, W., et al. (2024). Design of all-solid waste red mud-based cementitious materials based on the simplex centroid method. *Construction and Building Materials*, 418, 135439.