# Q1

1. Location model

A screenshot of a computer program

Description automatically generated

Half Normal Plot

A graph with black dots

Description automatically generatedA screenshot of a computer code

Description automatically generated



From the plot we can see that effect (from left to right) CD, A, D, BCD, B, C, and BD are away from the linear line 🡪 this declare that these effect can be considered as significant.

Formal Testing

A computer code with numbers and letters

Description automatically generated

Knowing that the critical value to control EER at 5% level is around 3.38, thus we can conclude that effect A, B,C,D,BD,CD,BCD are significant at 5% level (as the calculated test statistic is greater than 3.38).

1. Dispersion model

A screenshot of a computer program

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Half normal plot

A graph with black dots

Description automatically generatedA computer screen shot of text

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From the half normal plot, we can see that (from left to right) effect CD and effect AB are far from the linear line. 🡪 thus we can say that effect CD and AB are significant according to the half normal plot.

Formal Testing

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From the formal testing output, we noticed that all t-statistic is less than the critical value of 2.93 and we can conclude that there are no significant effect at the 5% level.

1. To find the optimum process condition to minimize mean crack length, knowing that in the location model: effect A, B,C,D,BD,CD,BCD are significant at 5% level; and in the dispersion model there’s no significant effect at 5% level.

We have the signs of “A, B,C,D” to minimize the mean are “-, +, - +”.

# Q2

Replicates of each run = n = 3

K = 5, p = 1 with I = ABCDE

In a 16-run design with 3 replications for each run;

a)

for independent factors ABCD & E=ABCD / I = ABCDE

**I** = ABCDE

**A**=BCDE

**B**=ACDE

**C**=ABDE

**D**=ABCE

**AB**=CDE

**AC**=BDE

**AD**=BCE

**BC**=ADE

**BD**=ACE

**CD**=ABE

ABC=**DE**

ABD=**CE**

ACD=**BE**

BCD=**AE**

ABCD=**E**

According to effect hierarchical principle: only the bolded effect are estimatable; in location or dispersion model we need to have 2^(5-1) – 1 = 15 covariates.

**Location model**

A screenshot of a computer code

Description automatically generated

Formal testing:

A screenshot of a computer

Description automatically generated

With qsmmd(15,32,0.95)=3.14, we can conclude that A,AC,BD are significant effects in the location model at 5% level.

**Dispersion model**

A screenshot of a computer program

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According to the t.lns2 output, we can conclude that effect A,B,C,AB are significant at 5% level in the dispersion model.

Write the fitted location and dispersion models

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b) **Effect heredity principle** states that interaction terms should only be considered if the terms that come before the interaction are effective at explaining response variation.

Thus the fitted location model does not satisfy the effect heredity principle (included AC,BD but no parent effect B/C/D)

Thus we add effect B, (the larger absolute factorial effects) into the location model; and write down the following new fitted model

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c) to find the optimum process conditions to maximize the mean tensile strength:

in the location model, we have significant effect A B with signs “+” “+” to maximize the mean;

to minimize the variance, we have the 12th run with signs “+,+,+,-,-” with the minimum variance.

d) to find the optimum process conditions to minimize the variability of tensile strength:

for the dispersion mode, we have significant effect ABC with ssigns “+++” to minimize variance;

to maximize the mean, we have the 8th run with signs of “+++++”.