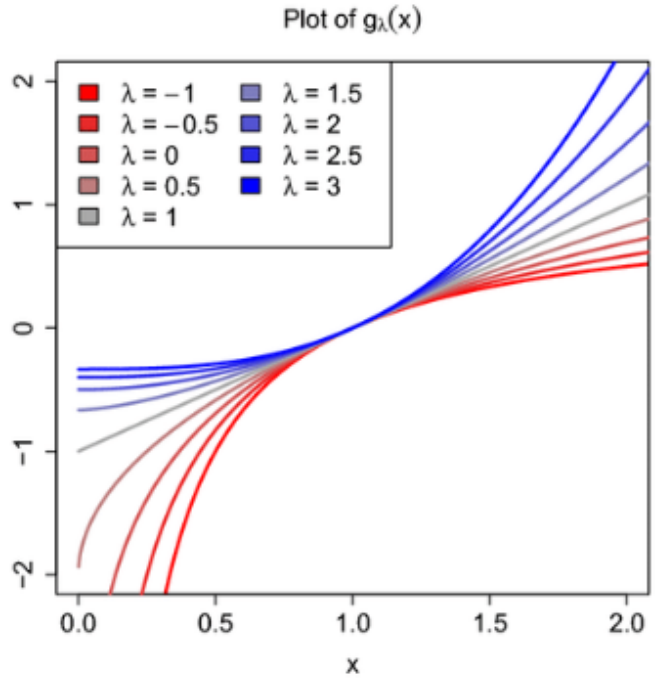
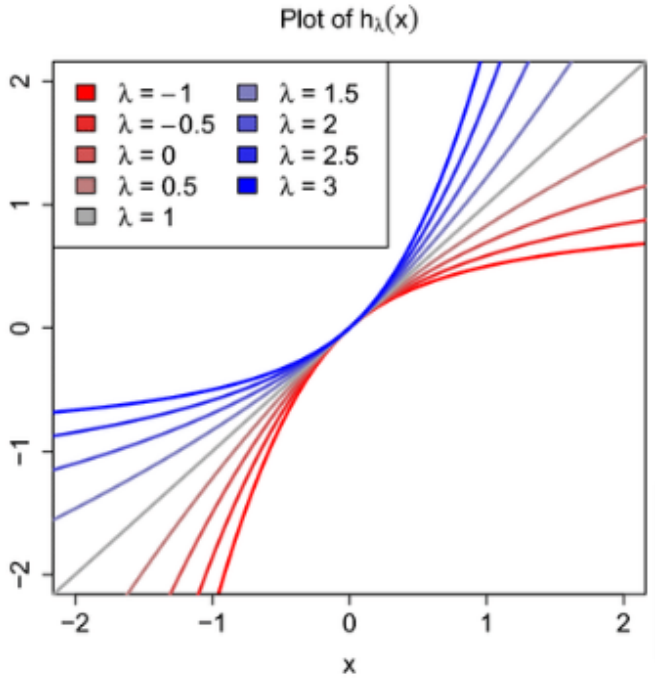
Feature Engineering 101

Topic - 3

Power Transformer





In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

import scipy.stats as stats


from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score

from sklearn.linear_model import LinearRegression

from sklearn.metrics import r2_score

from sklearn.preprocessing import PowerTransformer
```

In [2]:
```
df = pd.read_csv('concrete_data.csv')
```

In [3]:
```
df.sample(5)
```

Out[3]:

	Cement	Blast Furnace Slag	Fly Ash	Water	Superplasticizer	Coarse Aggregate	Fine Aggregate	Age	Strength
964	143.7	170.2	132.6	191.6	8.5	814.1	805.3	28	29.87
536	393.0	0.0	0.0	192.0	0.0	940.6	785.6	28	39.60
919	313.0	0.0	0.0	178.0	8.0	1000.0	822.0	28	25.10
795	525.0	0.0	0.0	189.0	0.0	1125.0	613.0	180	61.92
232	213.7	98.1	24.5	181.7	6.9	1065.8	785.4	56	50.77

In [4]:
```
df.shape
```

Out[4]:
```
(1030, 9)
```

In [5]:
```
df.isnull().sum()
```

Out[5]:
```
Cement                0
Blast Furnace Slag    0
Fly Ash               0
Water                 0
Superplasticizer      0
Coarse Aggregate      0
Fine Aggregate        0
Age                   0
Strength              0
dtype: int64
```

In [6]:
```
df.describe()
```

Out[6]:

	Cement	Blast Furnace Slag	Fly Ash	Water	Superplasticizer	Coarse Aggregate	Fine Aggregate	Age
count	1030.000000	1030.000000	1030.000000	1030.000000	1030.000000	1030.000000	1030.000000	1030.000000
mean	281.167864	73.895825	54.188350	181.567282	6.204660	972.918932	773.580485	45.662136
std	104.506364	86.279342	63.997004	21.354219	5.973841	77.753954	80.175980	63.169912
min	102.000000	0.000000	0.000000	121.800000	0.000000	801.000000	594.000000	1.000000
25%	192.375000	0.000000	0.000000	164.900000	0.000000	932.000000	730.950000	7.000000
50%	272.900000	22.000000	0.000000	185.000000	6.400000	968.000000	779.500000	28.000000
75%	350.000000	142.950000	118.300000	192.000000	10.200000	1029.400000	824.000000	56.000000
max	540.000000	359.400000	200.100000	247.000000	32.200000	1145.000000	992.600000	365.000000

In [7]:
```
X = df.drop(columns=['Strength'])
y = df.iloc[:,-1]
```

In [8]:
```
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2,random_state=52)
```

Applying Regression without any transformation

In [9]:
```
lr = LinearRegression()

lr.fit(X_train,y_train)

y_pred = lr.predict(X_test)

r2_score(y_test,y_pred)
```

Out[9]:
```
0.601364413277667
```

In [10]:
```
# Cross checking with cross val score
lr = LinearRegression()
np.mean(cross_val_score(lr,X,y,scoring='r2'))
```

Out[10]:
```
0.4609940491662866
```

In [11]:
```
!pip install seaborn
```

```
Requirement already satisfied: seaborn in c:\programdata\anaconda3\lib\site-packages (0.1
1.2)
Requirement already satisfied: pandas>=0.23 in c:\programdata\anaconda3\lib\site-packages
(from seaborn) (1.3.4)
Requirement already satisfied: numpy>=1.15 in c:\programdata\anaconda3\lib\site-packages
(from seaborn) (1.20.3)
Requirement already satisfied: matplotlib>=2.2 in c:\programdata\anaconda3\lib\site-packag
es (from seaborn) (3.4.3)
Requirement already satisfied: scipy>=1.0 in c:\programdata\anaconda3\lib\site-packages (f
rom seaborn) (1.7.1)
Requirement already satisfied: cycler>=0.10 in c:\programdata\anaconda3\lib\site-packages
(from matplotlib>=2.2->seaborn) (0.10.0)
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(from matplotlib>=2.2->seaborn) (8.4.0)
Requirement already satisfied: python-dateutil>=2.7 in c:\programdata\anaconda3\lib\site-p
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Requirement already satisfied: kiwisolver>=1.0.1 in c:\programdata\anaconda3\lib\site-pack
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Requirement already satisfied: six in c:\programdata\anaconda3\lib\site-packages (from cyc
ler>=0.10->matplotlib>=2.2->seaborn) (1.16.0)
Requirement already satisfied: pytz>=2017.3 in c:\programdata\anaconda3\lib\site-packages
(from pandas>=0.23->seaborn) (2021.3)
WARNING: Ignoring invalid distribution -oblib (c:\programdata\anaconda3\lib\site-packages)
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```

In [12]:
```
# Plotting the distplots without any transformation

for col in X_train.columns:
    plt.figure(figsize=(14,4))
    plt.subplot(121)
    sns.distplot(X_train[col])
    plt.title(col)

    plt.subplot(122)
    stats.probplot(X_train[col], dist="norm", plot=plt)
    plt.title(col)

    plt.show()
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `
distplot` is a deprecated function and will be removed in a future version. Please adapt y
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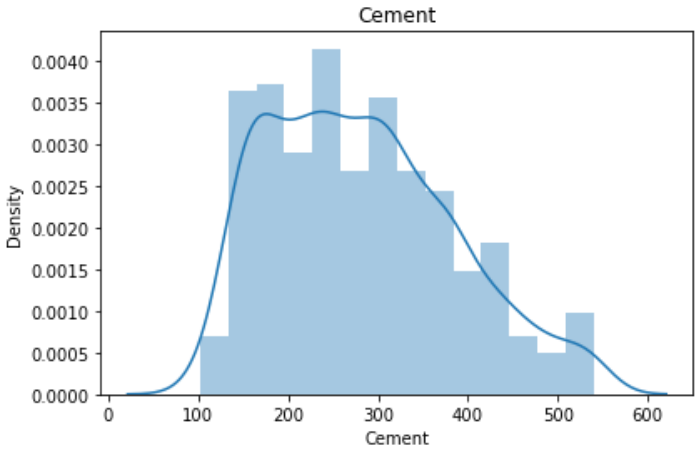

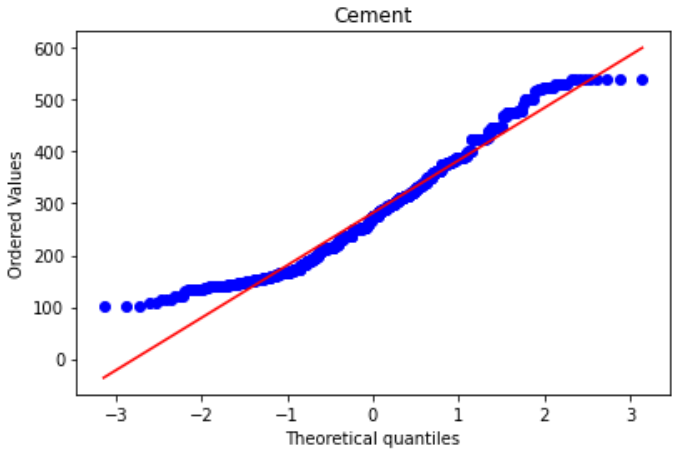


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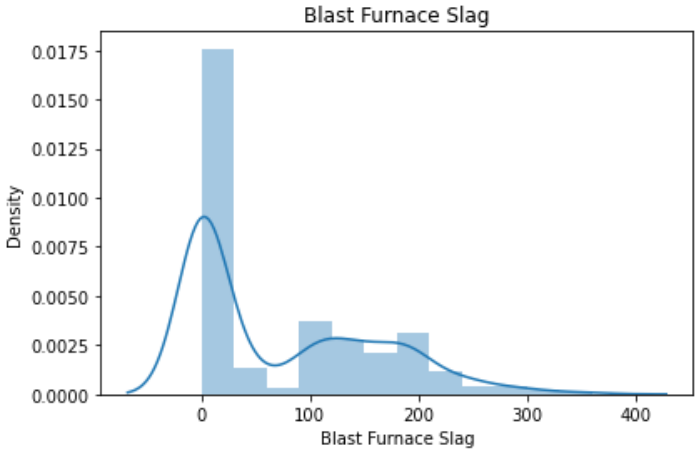

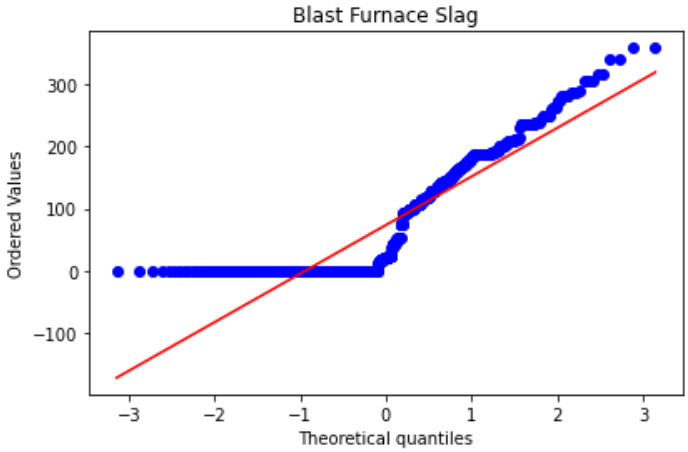


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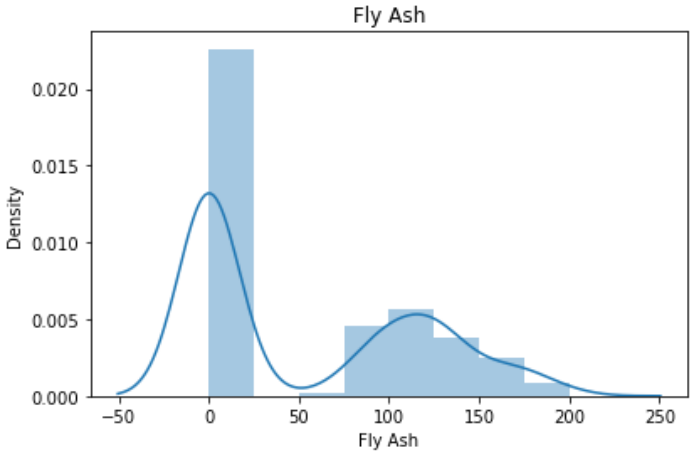

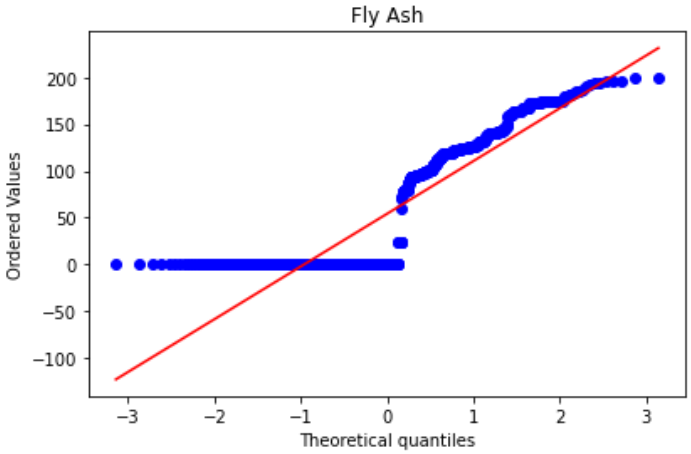


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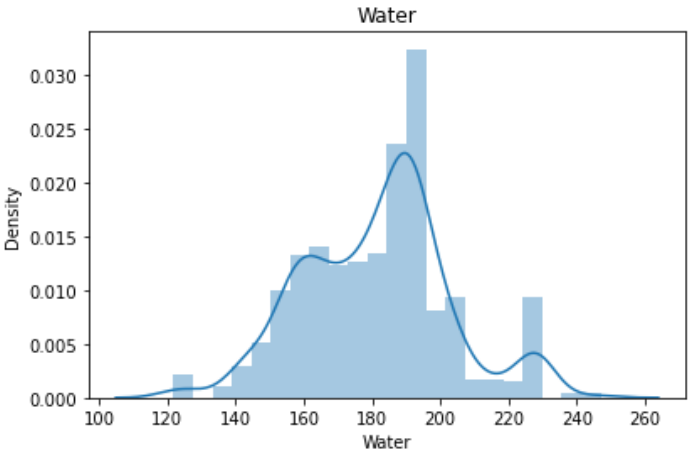

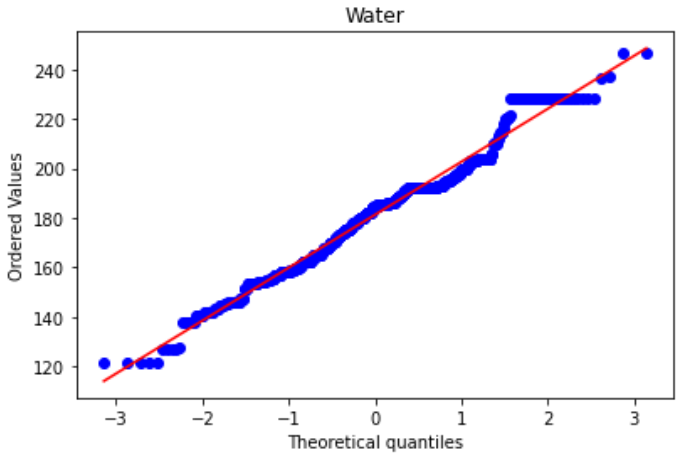


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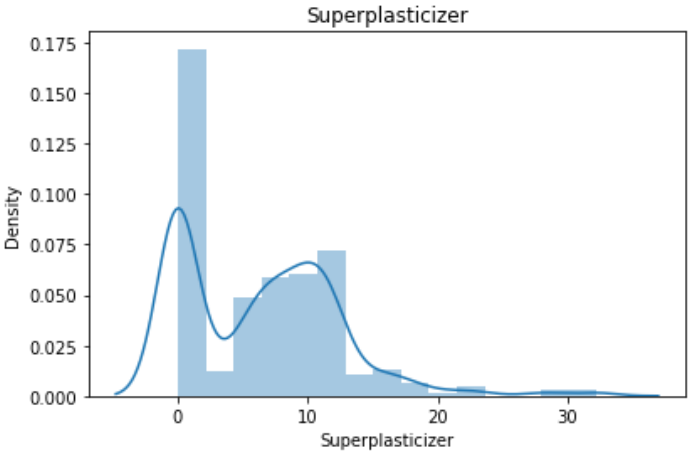

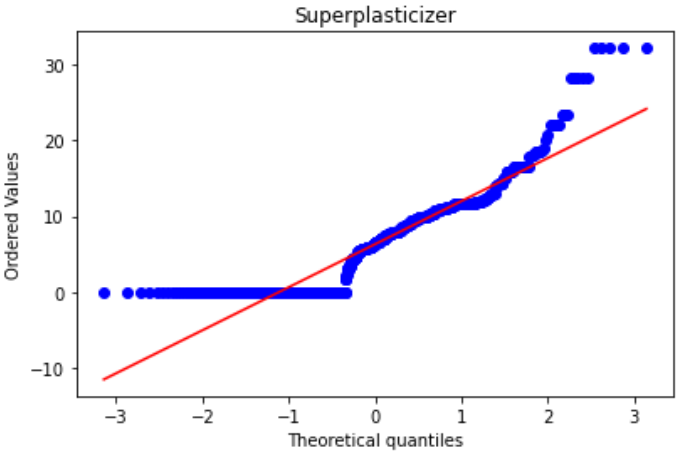


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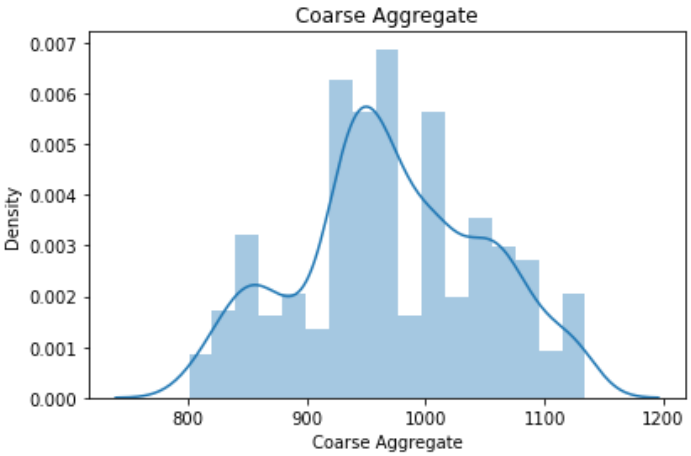

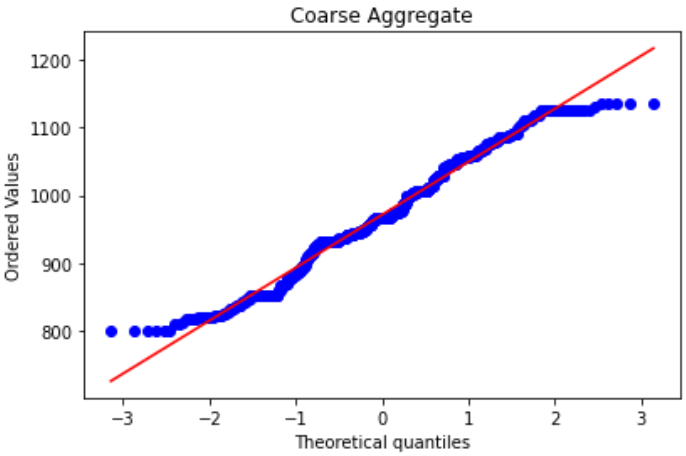


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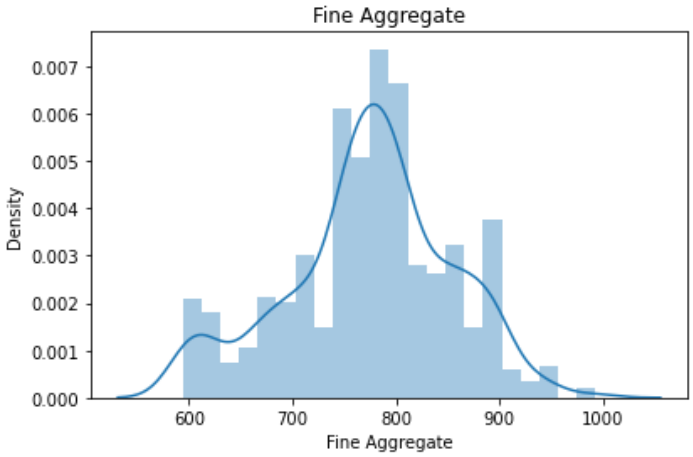

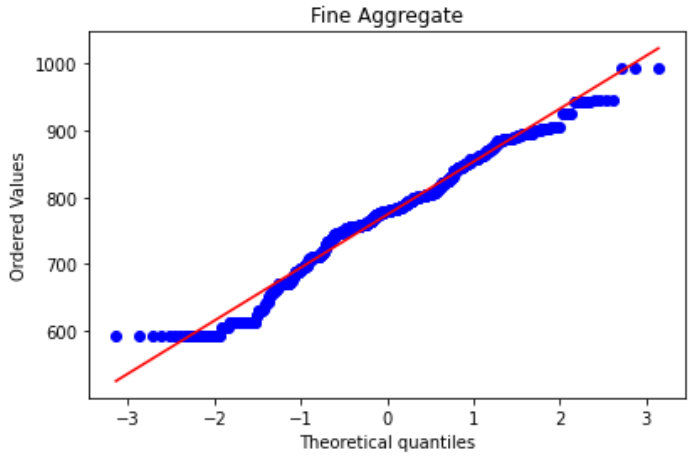


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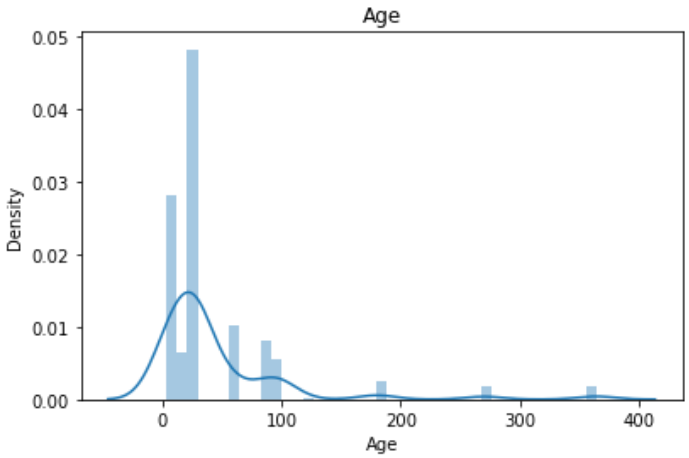

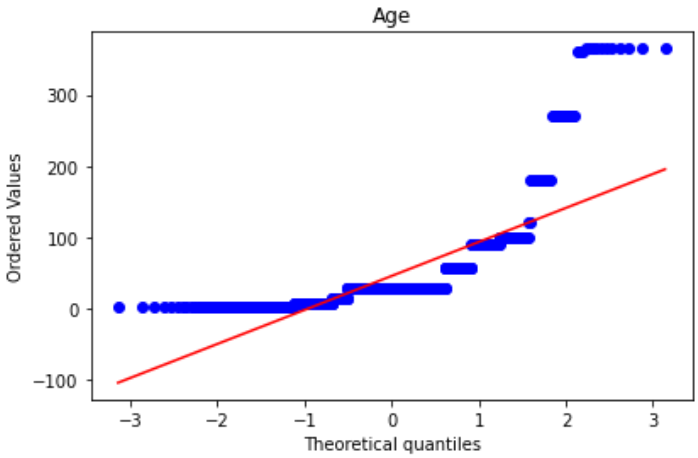

Applying Box-Cox Transform

In [13]:
```
pt = PowerTransformer(method='box-cox')
```

In [14]:
```
X_train_transformed = pt.fit_transform(X_train+0.000001)
X_test_transformed = pt.transform(X_test+0.000001)

pd.DataFrame({'cols':X_train.columns,'box_cox_lambdas':pt.lambdas_})
```

Out[14]:

	cols	box_cox_lambdas
0	Cement	0.192177
1	Blast Furnace Slag	0.023543
2	Fly Ash	-0.033365
3	Water	0.729294
4	Superplasticizer	0.102799
5	Coarse Aggregate	0.944492
6	Fine Aggregate	1.912493
7	Age	0.050675

In [15]:
```
# Applying linear regression on transformed data

lr = LinearRegression()
lr.fit(X_train_transformed,y_train)

y_pred2 = lr.predict(X_test_transformed)

r2_score(y_test,y_pred2)
```

Out[15]:
```
0.8059395299868048
```

In [16]:
```
# Using cross val score

pt = PowerTransformer(method='box-cox')
X_transformed = pt.fit_transform(X+0.0000001)

lr = LinearRegression()
np.mean(cross_val_score(lr,X_transformed,y,scoring='r2'))
```

Out[16]:
```
0.6658537942219862
```

In [17]:
```
# Before and after comparision for Box-Cox Plot
X_train_transformed = pd.DataFrame(X_train_transformed,columns=X_train.columns)

for col in X_train_transformed.columns:
    plt.figure(figsize=(14,4))
    plt.subplot(121)
    sns.distplot(X_train[col])
    plt.title(col)

    plt.subplot(122)
    sns.distplot(X_train_transformed[col])
    plt.title(col)



    plt.show()
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `
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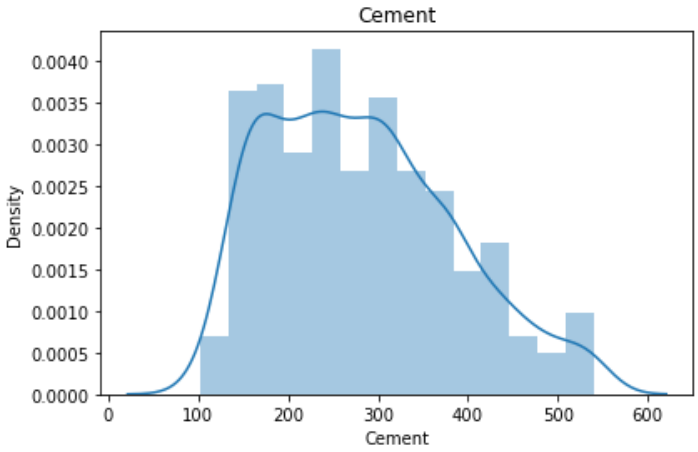

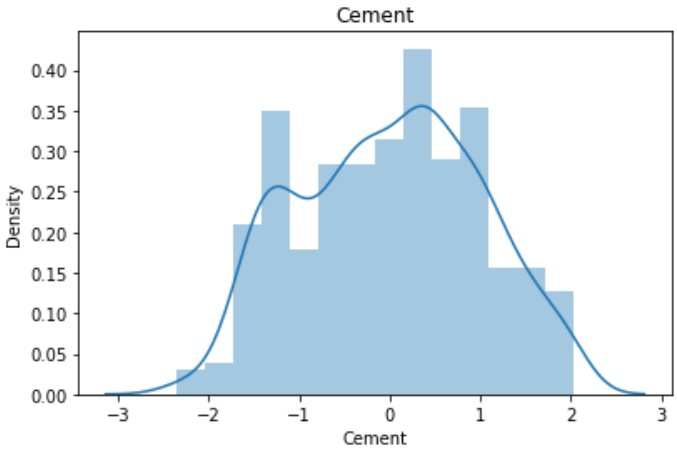


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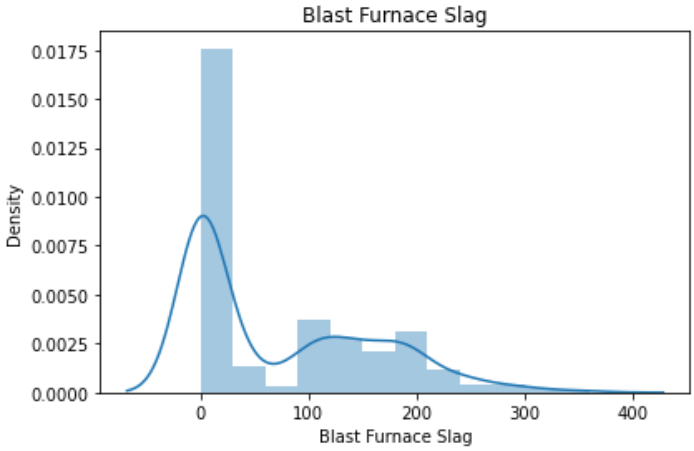

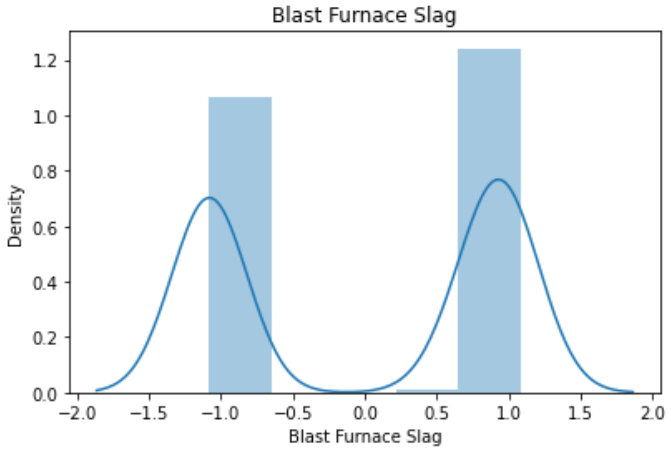


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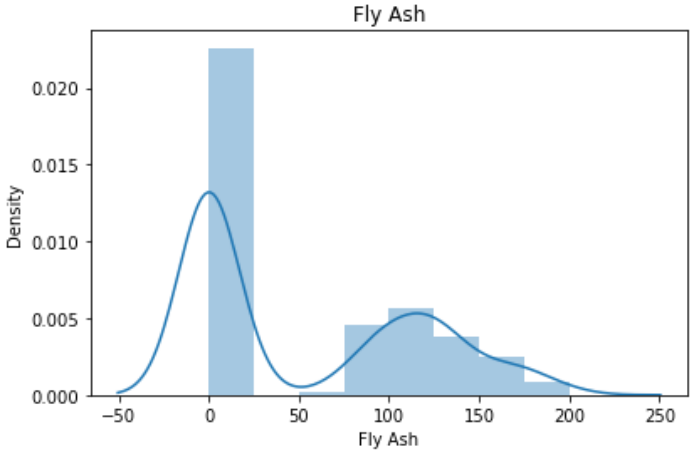

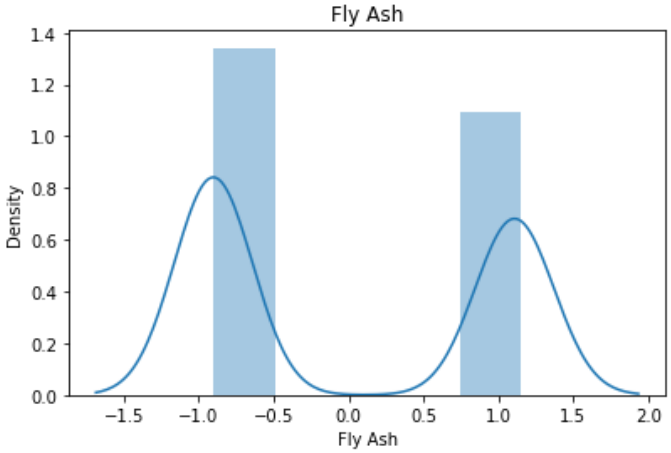

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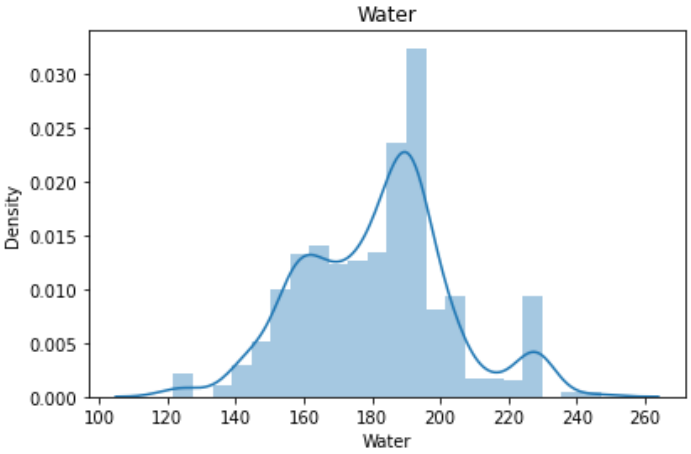

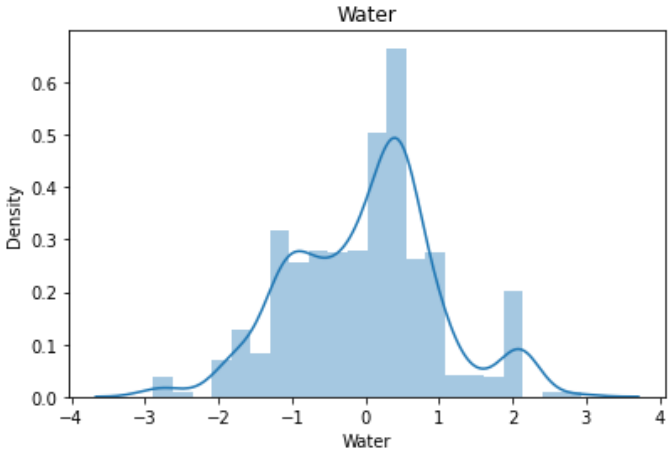


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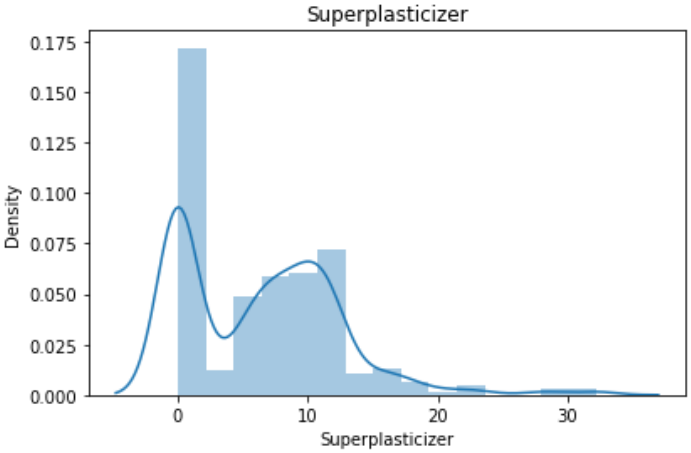

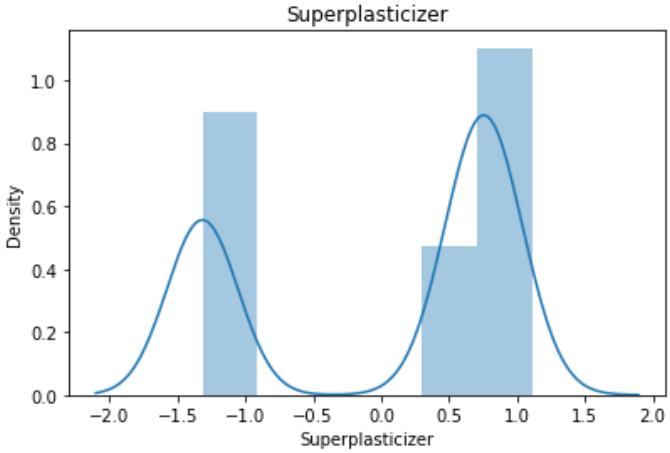


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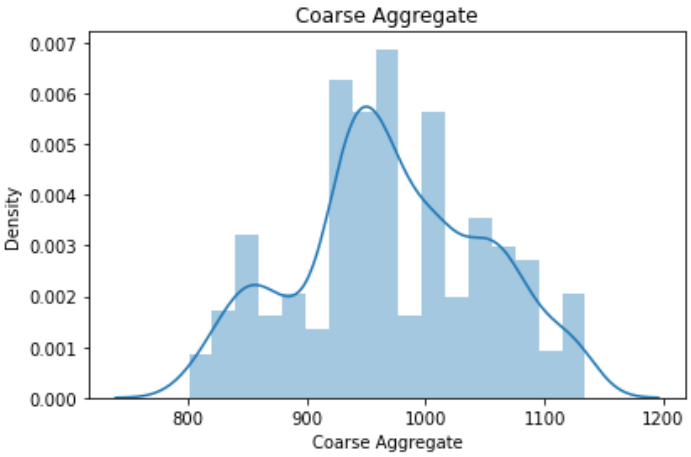

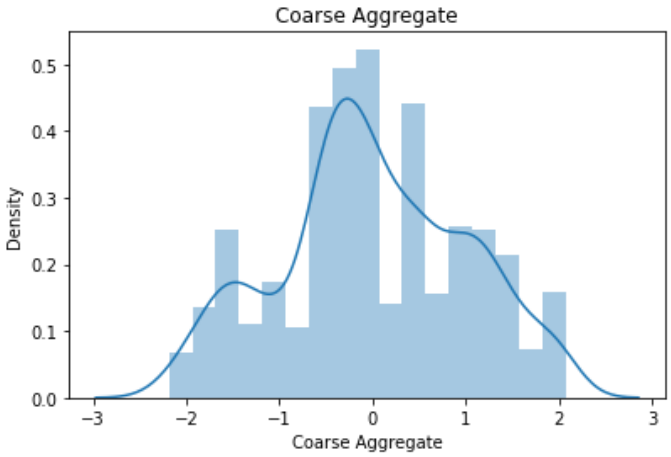


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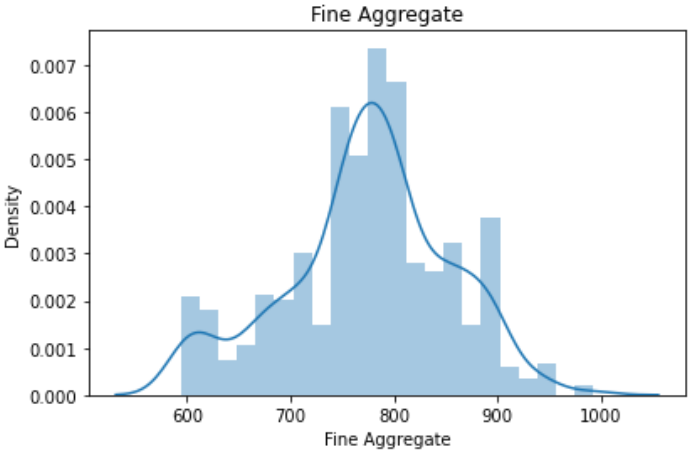

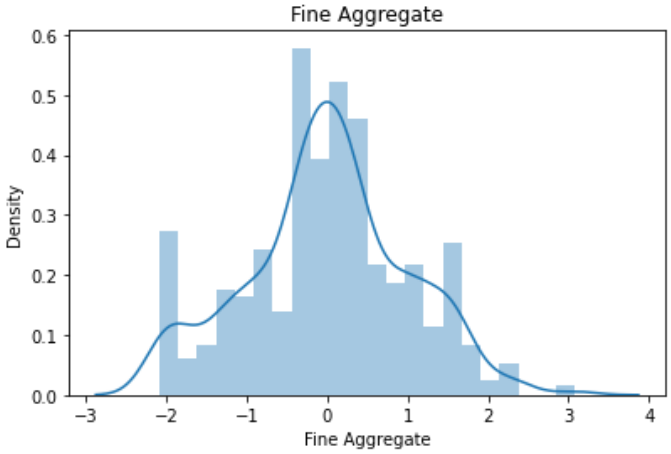


```
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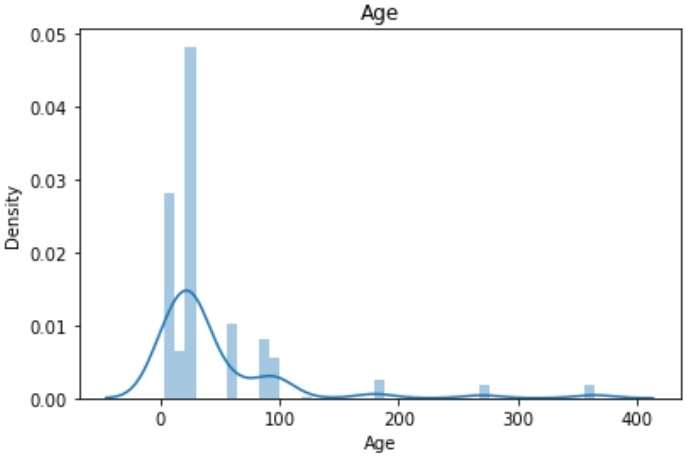

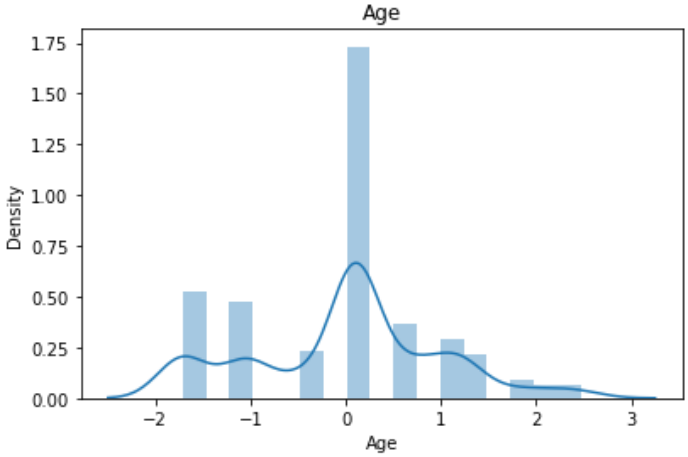

Apply Yeo-Johnson transform

In [18]:
```
pt1 = PowerTransformer()
```

In [19]:
```
X_train_transformed2 = pt1.fit_transform(X_train)
X_test_transformed2 = pt1.transform(X_test)

lr = LinearRegression()
lr.fit(X_train_transformed2,y_train)

y_pred3 = lr.predict(X_test_transformed2)

print(r2_score(y_test,y_pred3))

pd.DataFrame({'cols':X_train.columns,'Yeo_Johnson_lambdas':pt1.lambdas_})
```

```
0.8096460862674353
```

Out[19]:

	cols	Yeo_Johnson_lambdas
0	Cement	0.189513
1	Blast Furnace Slag	0.010273
2	Fly Ash	-0.140102
3	Water	0.727681
4	Superplasticizer	0.271741
5	Coarse Aggregate	0.944526
6	Fine Aggregate	1.913745
7	Age	0.005244

In [20]:
```
# applying cross val score

pt = PowerTransformer()
X_transformed2 = pt.fit_transform(X)

lr = LinearRegression()
np.mean(cross_val_score(lr,X_transformed2,y,scoring='r2'))
```

Out[20]:
```
0.6834625134285743
```

In [21]:
```
X_train_transformed2 = pd.DataFrame(X_train_transformed2,columns=X_train.columns)
```

In [22]:
```
X_train_transformed2
```

Out[22]:

	Cement	Blast Furnace Slag	Fly Ash	Water	Superplasticizer	Coarse Aggregate	Fine Aggregate	Age
0	-0.009023	0.904728	1.024625	-0.137365	0.776304	-0.786372	-0.407202	0.104565
1	-0.604728	-1.052106	1.132351	-1.035647	0.529274	1.450927	0.282969	1.248846
2	-0.603517	-1.052106	1.124763	-0.030435	0.247086	1.097752	0.021980	-1.696745
3	1.636626	-1.052106	-0.900126	2.111781	-1.233985	-0.504527	-2.085586	2.159262

	Cement	Blast Furnace Slag	Fly Ash	Water	Superplasticizer	Coarse Aggregate	Fine Aggregate	Age
4	0.938188	-1.052106	-0.900126	0.425694	0.388456	0.532615	-0.584531	0.104565
...	...	...	...	...	...	...	...	...
819	-1.697137	1.141106	1.060729	0.825766	0.291024	-1.595598	0.069329	0.104565
820	0.847477	1.125678	-0.900126	-0.753743	0.934141	-0.341994	-0.273968	-1.696745
821	1.142699	0.834321	-0.900126	-1.598327	0.915241	-0.315130	0.991109	0.723317
822	0.271409	-1.052106	-0.900126	0.186935	-1.233985	1.242641	-0.108751	0.104565
823	0.794462	-1.052106	1.168879	0.567189	0.876763	-2.183395	0.010493	0.104565

824 rows × 8 columns

In [23]:

```
# Before and after comparision for Yeo-Johnson

for col in X_train_transformed2.columns:
    plt.figure(figsize=(14,4))
    plt.subplot(121)
    sns.distplot(X_train[col])
    plt.title(col)

    plt.subplot(122)
    sns.distplot(X_train_transformed2[col])
    plt.title(col)

    plt.show()
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning: `
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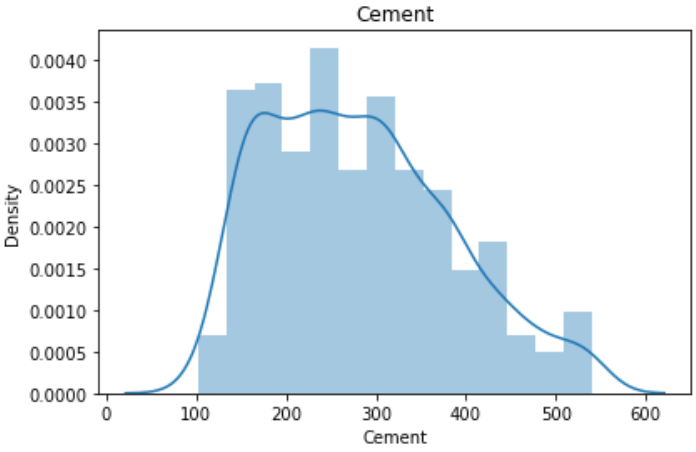

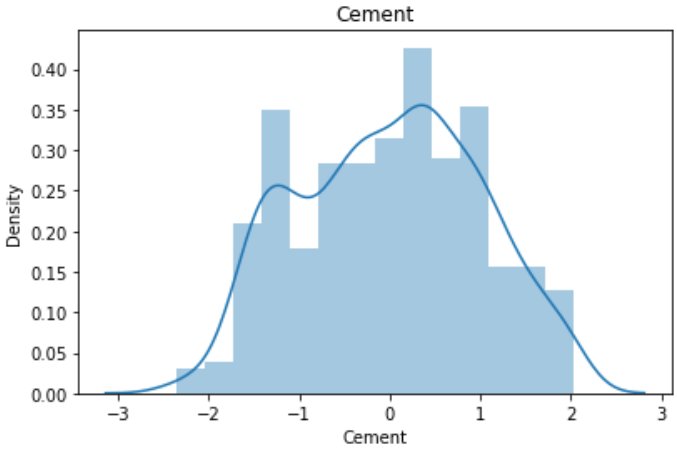


```
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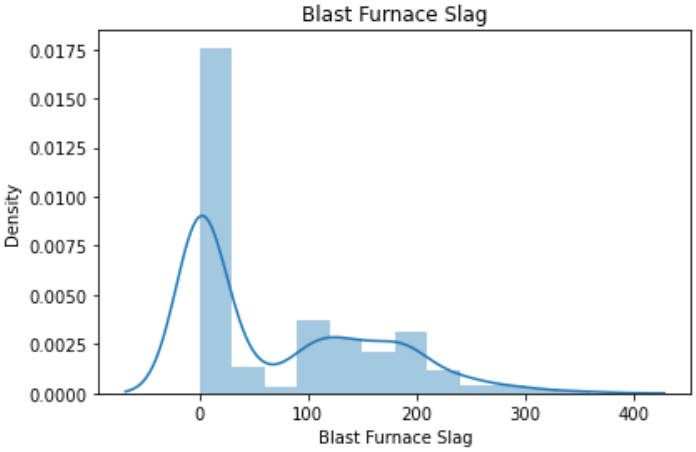

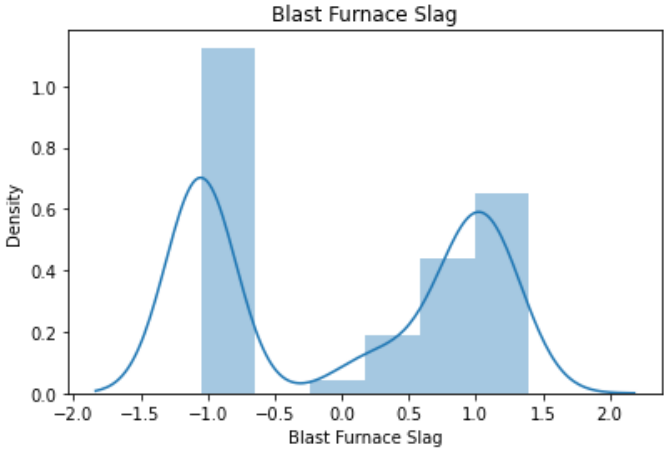


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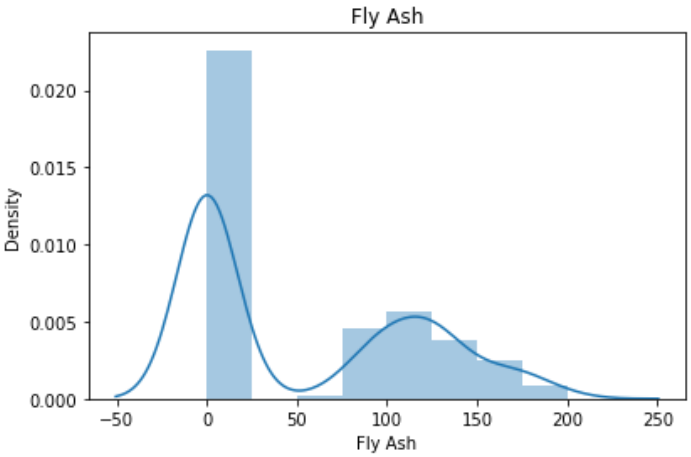

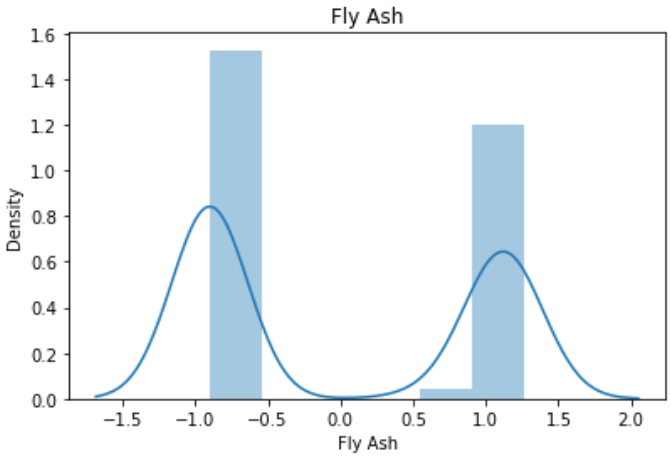


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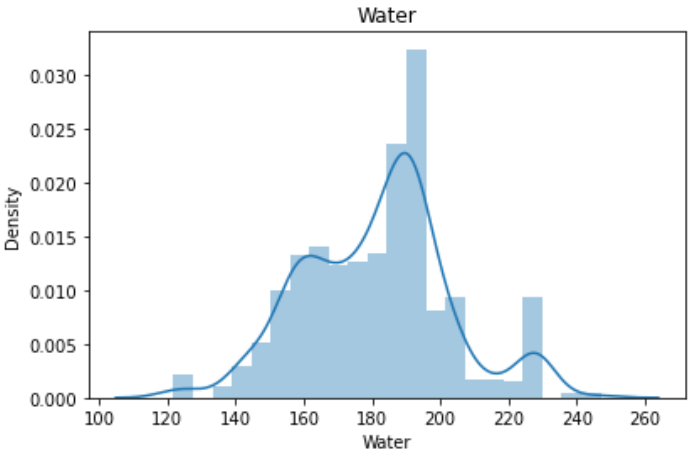

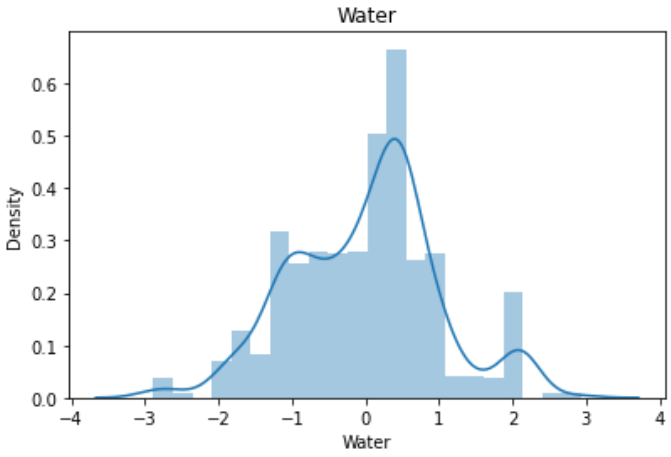


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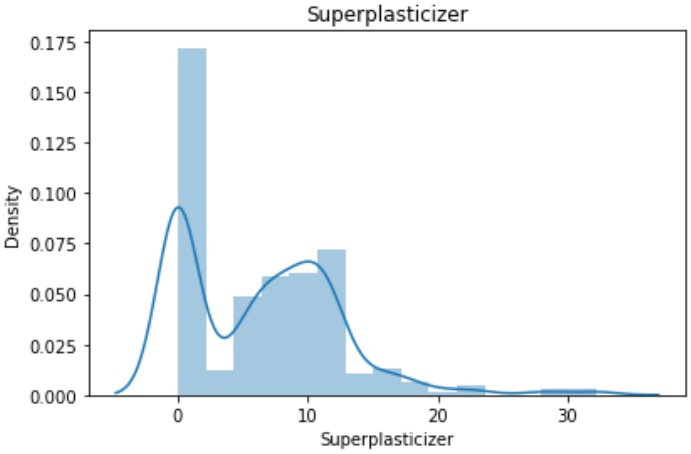

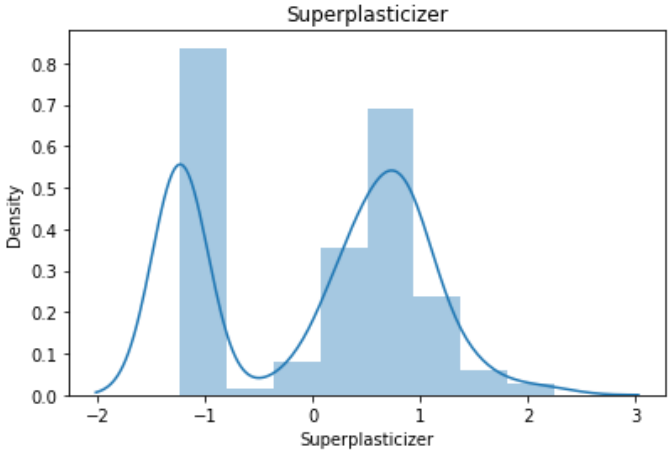


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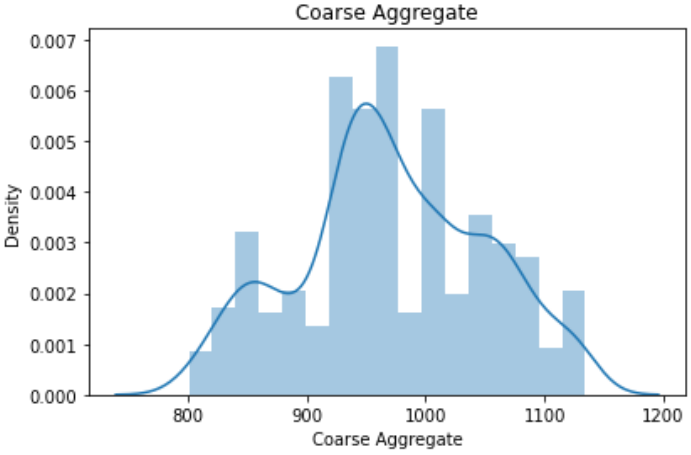

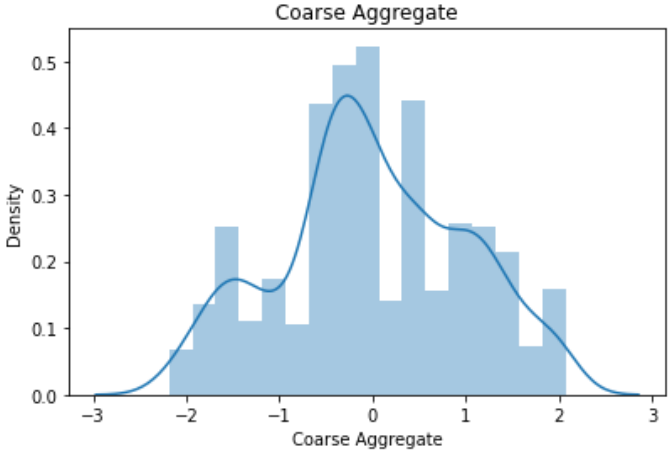

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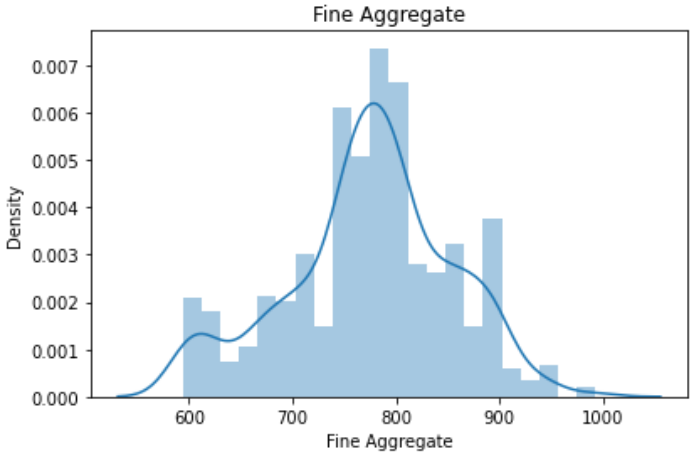

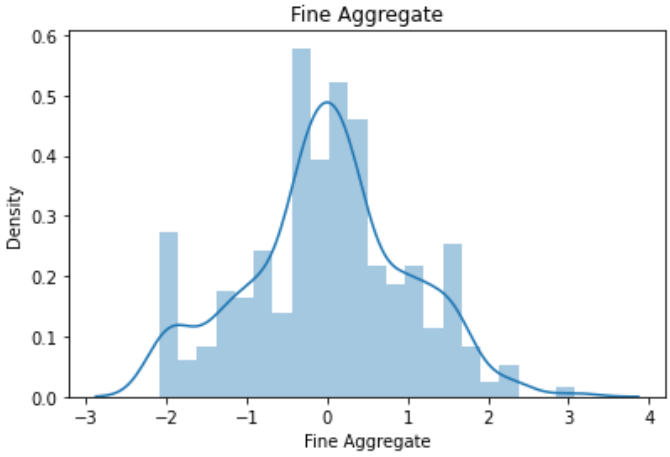


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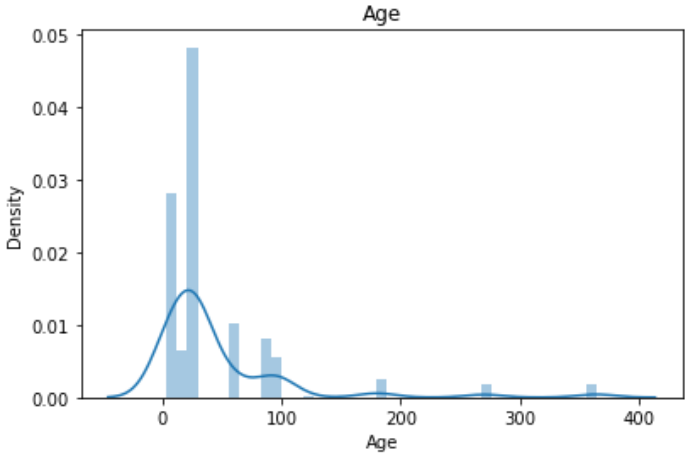

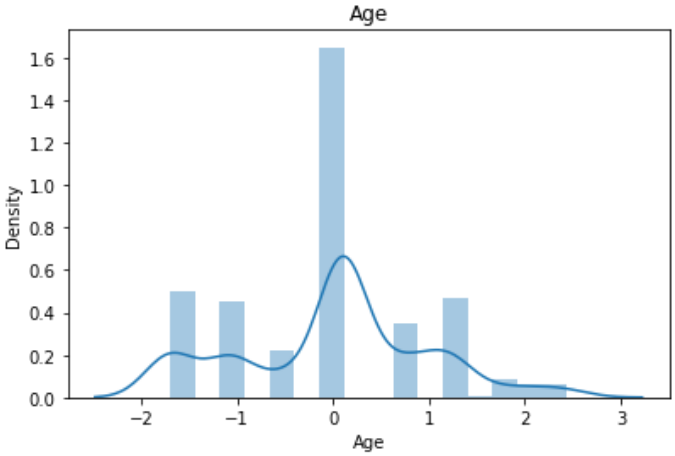

$$x_i^{(\lambda)} = \begin{cases} \dfrac{x_i^{\lambda} - 1}{\lambda} & \text{if } \lambda \neq 0, \\ \ln(x_i) & \text{if } \lambda = 0, \end{cases}$$

In [24]:

```
# Side by side Lambdas
pd.DataFrame({'cols':X_train.columns,'box_cox_lambdas':pt.lambdas_,'Yeo_Johnson_lambdas':p
```

Out[24]:

	cols	box_cox_lambdas	Yeo_Johnson_lambdas
0	Cement	0.169544	0.189513
1	Blast Furnace Slag	0.016633	0.010273
2	Fly Ash	-0.136480	-0.140102
3	Water	0.808438	0.727681
4	Superplasticizer	0.264160	0.271741
5	Coarse Aggregate	1.129395	0.944526
6	Fine Aggregate	1.830763	1.913745
7	Age	0.001771	0.005244

In [ ]: