Fiber in Concrete

When does it succeed?

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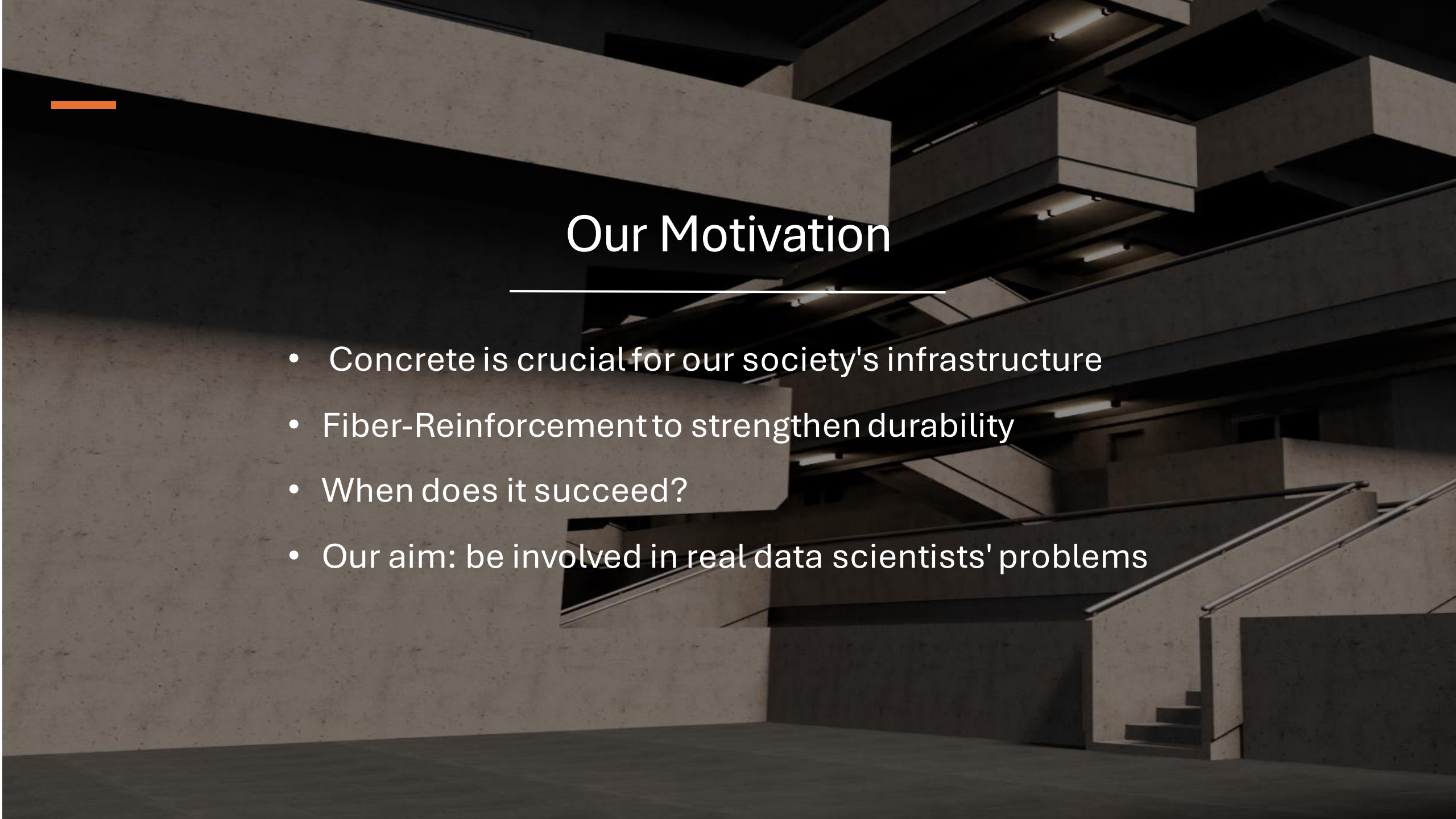


Our Motivation

- Concrete is crucial for our society's infrastructure
- Fiber-Reinforcement to strengthen durability
- When does it succeed?
- Our aim: be involved in real data scientists' problems

The Data

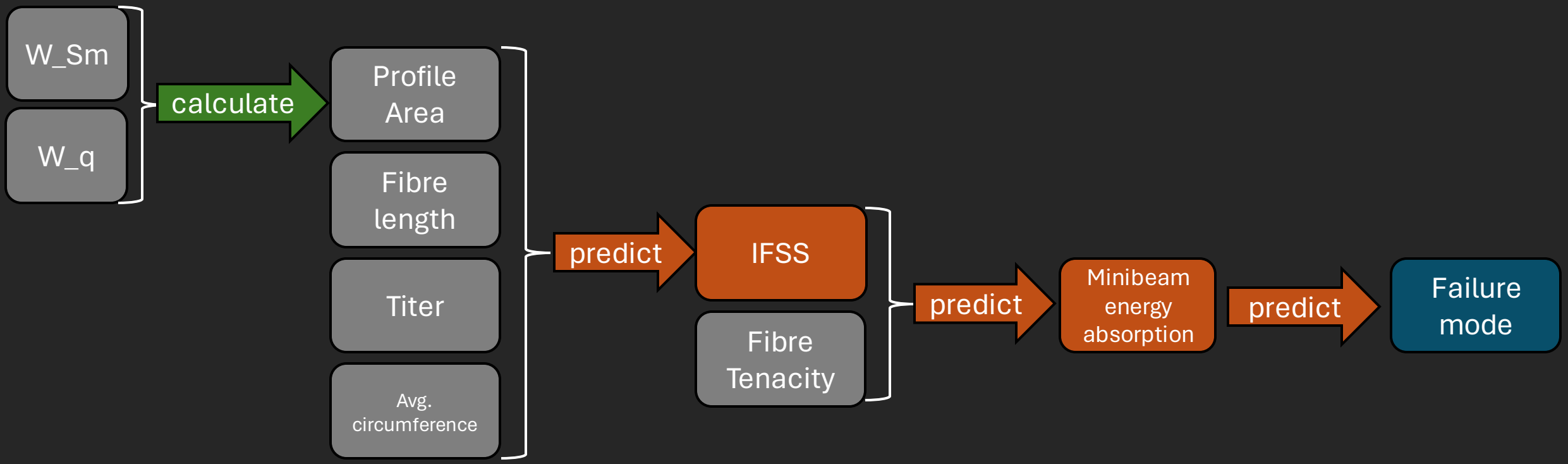
- Sourced from a series of experimental trials by the SIKA R&D-department
- 1440 observations and 10 variables:
  - Titer [tex]
  - average circumference [mm]R
  - fiber length [mm]
  - fiber tenacity [mm]
  - surface waviness parameters W_sm and W_q [µm]
  - expected concrete compression strength 95% rH [mPa]
  - interfacial shear stress (IFSS)
  - Minibeam energy absorption [J]
  - fiber failure mode in beam (0 = success, 1 = failure)

The Goal - 3 Level Predictive Modeling

1. Level Hypothesis: IFSS
   - Interfacial sheer strength (IFSS) can be sufficiently predicted through the profile area, fibre length, avg. fibre circumference and Titer.
2. Level Hypothesis: Minibeam energy absorption
   - IFSS and fibre tenacity can be used to sufficiently predict Minibeam energy absorption and subsequently failure.
3. Level Hypothesis: IFSS
   - Failure Mode can be predicted from minibeam energy absorption.

The Goal – Flowchart

3 Level Predictive Modeling



The Catch

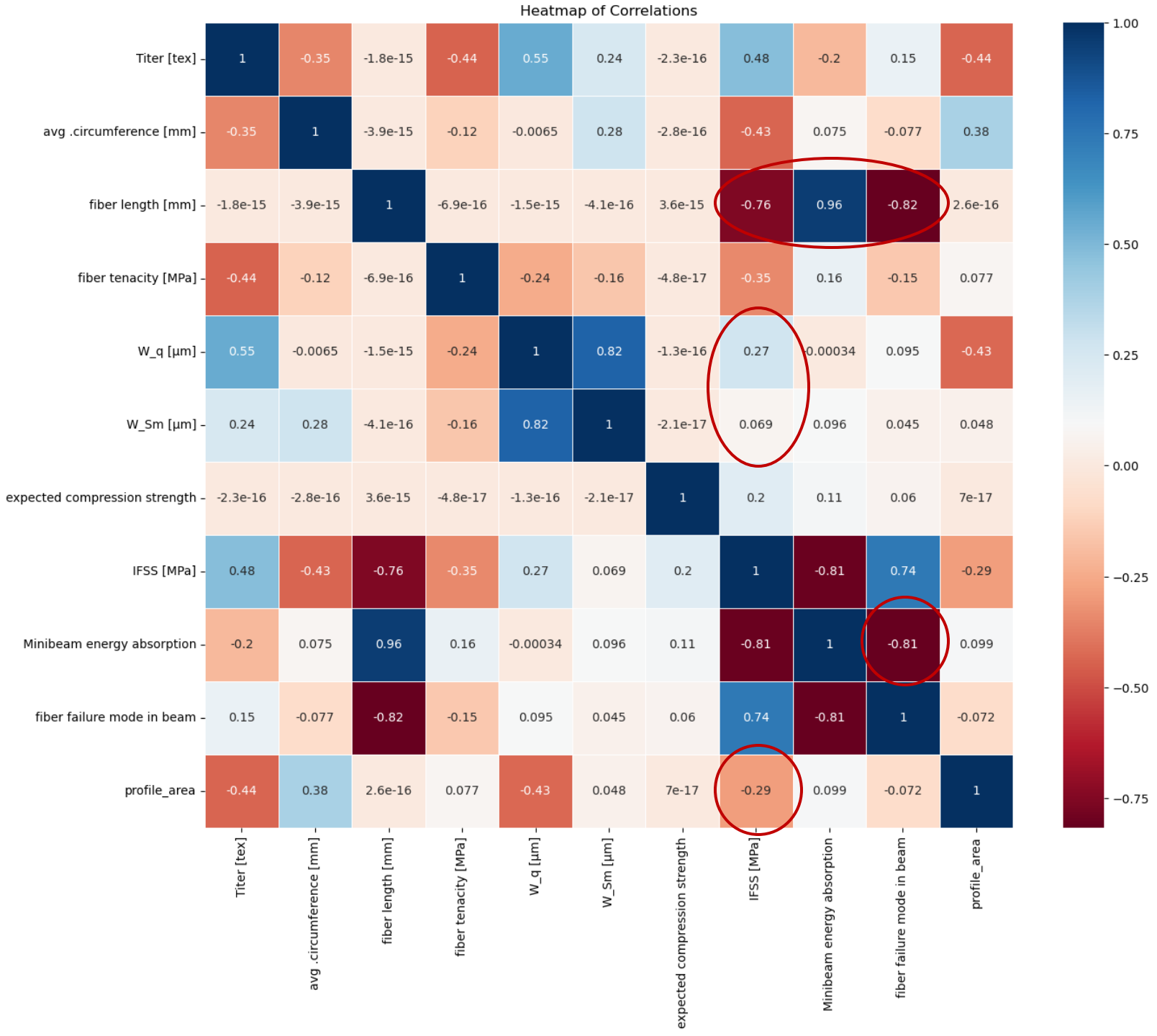
- In the Field, it is common that not all parameters are known
- To be applicable to the real-world, this issue has to be dealt with
- Prediction of missing parameters is often not possible

Solution:

- Create multiple models and figure out which works best for which missing data
- Incorporate a decision-tree approach were the most reliable model is chosen for the situation

The EDA

- No significant outliers found with z-scores > 3 or <-3
- Some significant correlations found through PearsonsR
- Some unexpected correlations with fibre length
- Not a perfect correlation between failure mode and energy absorption



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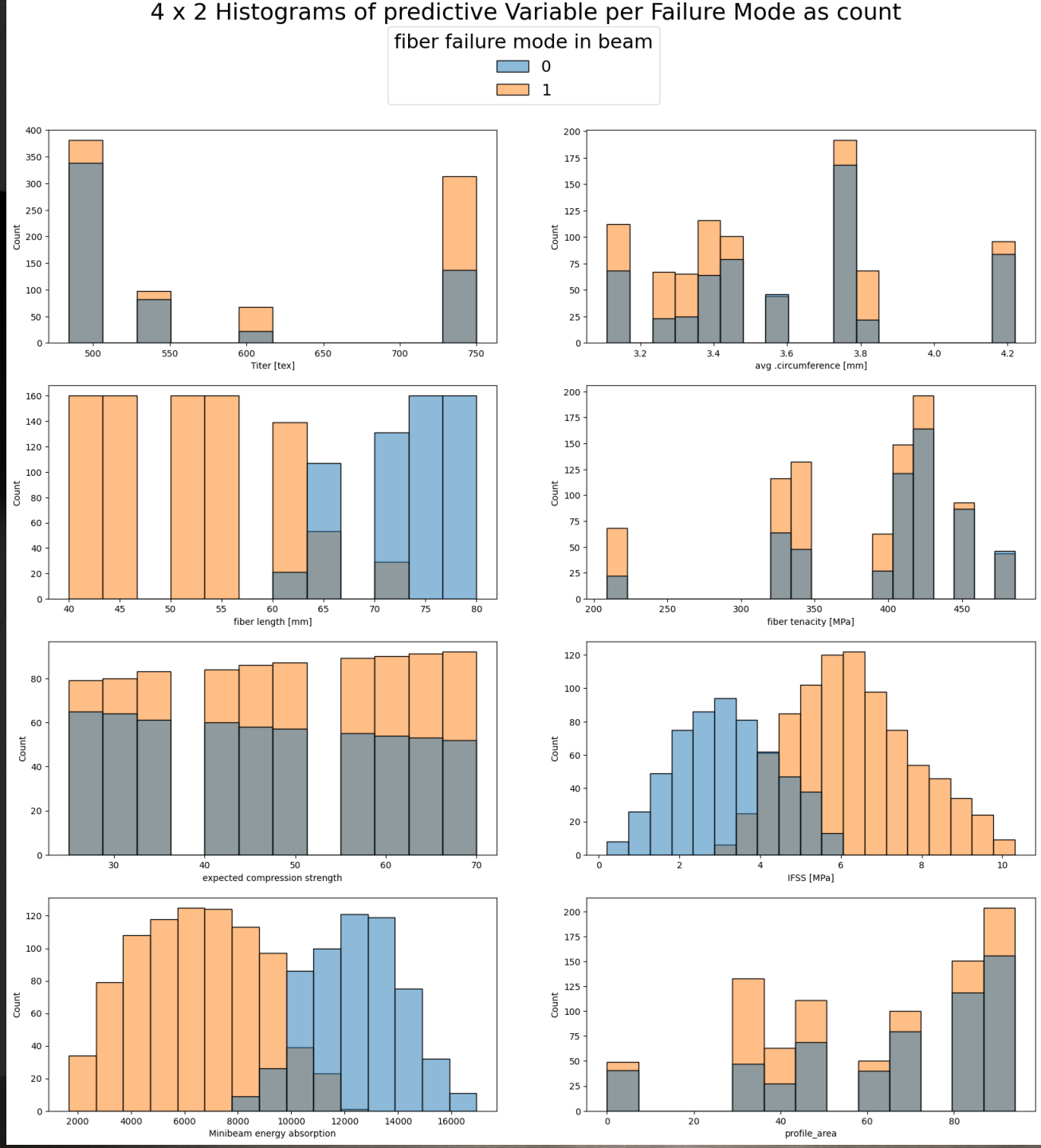
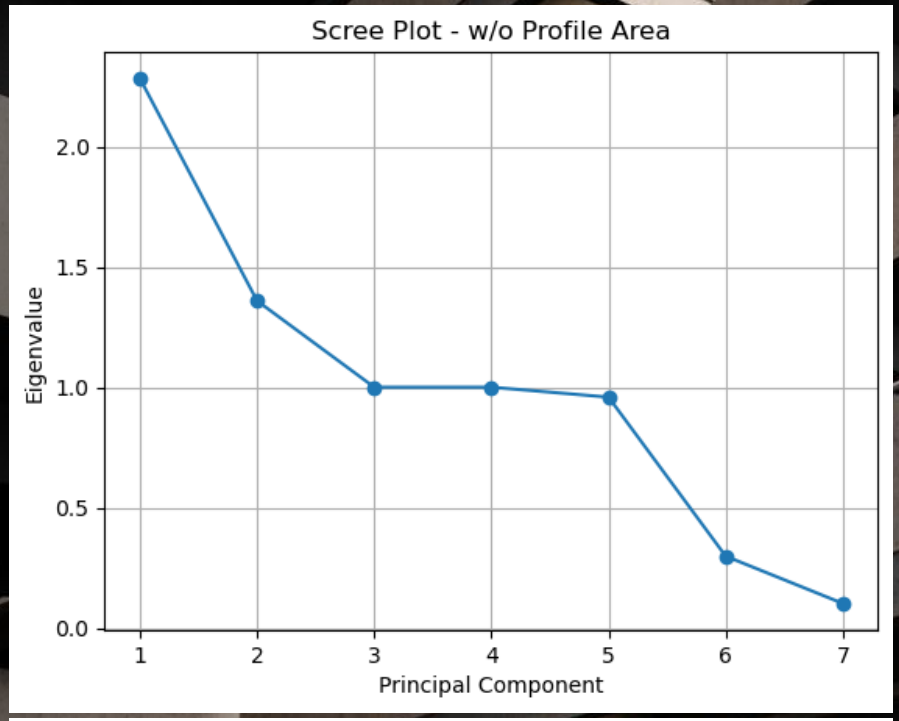
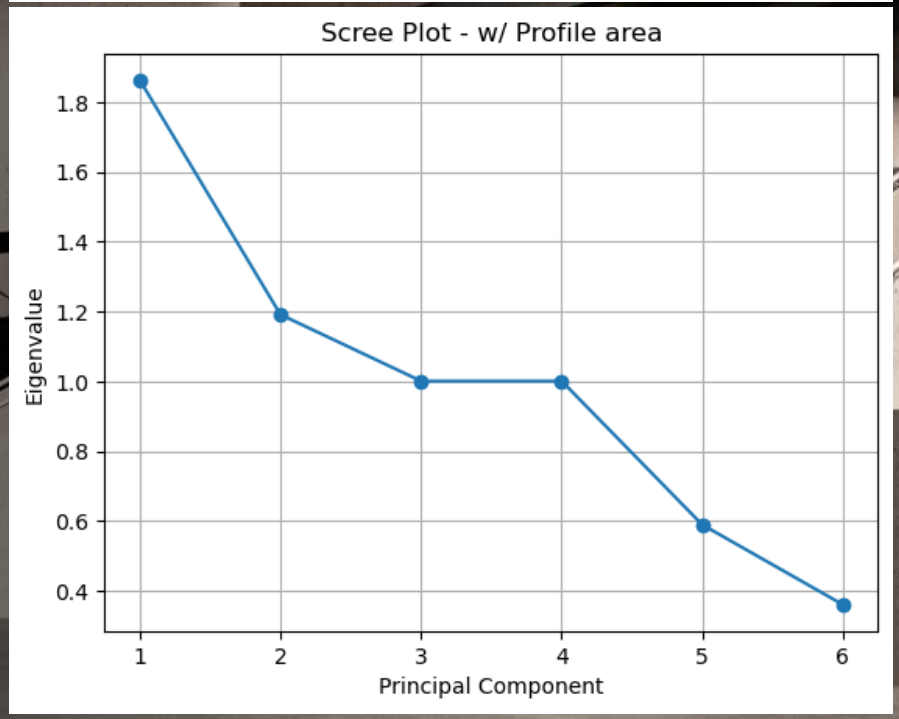


The PCA

- Suggests dimensionality reduction to 4 or 5 principal components
- Due to the relatively small size of the data and the ease of computing, we chose to continue to utilize the full dataset w/o Profile Area to increase prediction quality





The Models

- Predictions utilizing Ridge Regression, Lasso Regression, RandomForest, Gradient Boosting & SVR

```
def train_models(predictor_combinations, MODELS, hyperparameters):
    for subset in predictor_combinations:
        for model in MODELS:
            for hyperparameter_subset in hyperparemeters[model]:
                model.fit(X, y)
                score <- rmse(model)
                if score < best_score:
                    best_score <- score
                    best_model <- model

        store(best_model)
```

Streamlit Live-Demo

Streamlit