Effect of hardness and detergent on enzymatic catalysis

Background
In the detergent industry it is of interest to know the enzymes catalytic ability to remove certain stains on textile (surfaces). In a laundry wash process the enzyme performance is affected by various factors, e.g. the concentration of Calcium-ions (hardness), surface active components (detergents), and the concentration of the enzyme.

In the present project the enzyme performance is measured as the amount of protein that is removed from a surface. The method used to measure the amount of protein on a surface is a so called Surface Plasmon Resonance technology (SPR). Briefly the SPR technology measures a variation in a refractive index in proximity to a gold surface. This resonance signal is translated into changes in mass (density) in an aqueous layer close to a surface over which a solution is passing. The SPR phenomenon is used in so-called biosensor (lab-on-a-chip) instruments to get real-time information about molecular binding events at a solid-liquid interface.

Data
Data is collected during a period of 10 days. Each experiment takes about 2 days and includes: 1 enzyme under four conditions (Det0Ca0, Det0Ca1, Det1Ca0, Det1Ca1) for each concentration of enzyme (0nM, 2.5nM, 7.5nM, 15nM). The experiment is replicated and each replicate is analysed in random order. A references enzyme is placed in each experiment mainly to compensate for "the one enzyme per experiment" - These data are not included in the dataset.

The data file contains columns with:

RunDate:	Run date in the YYMMDD format
Cycle:	Cycle number within run.
Response:	Amount of protein removed by enzyme. In RU where 1 RU equals 10^{-6} g/m^2
Enzyme:	5-level factor
EnzymeConc:	Enzyme concentration in nM, either 4-level categorical factor or numeric.
DetStock:	With or without detergent (2-level factor)
CaStock:	Hardness (With or without Ca^{++})

Purpose
The aim of the present analysis is to describe and make inference about the enzymatic performance in the presence and absence of hardness and detergent. Questions include but are not limited to:

- How does hardness & detergent influence the catalytic activity?
- Is the catalytic activity dependent on the amount of enzyme present?
- Are there any differences in performance among the enzymes in this study regarding the factors mentioned above?
- Are there indications of systematic errors due to one enzyme per experiment, how would this affect the model?