Suction Caisson Foundations for Offshore Wind Turbines

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Outline
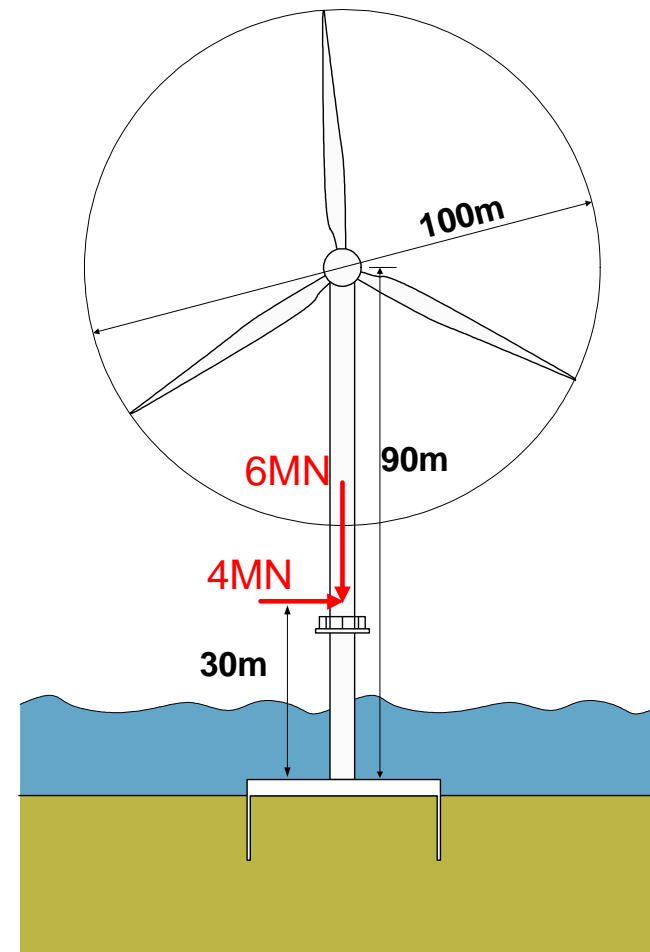
- Introduction
- Research programme
  - Lab tests
  - Analyses
  - Answers
  - Questions

Motivation

North Hoyle wind farm (2003)

100m

90m

6MN

4MN

30m

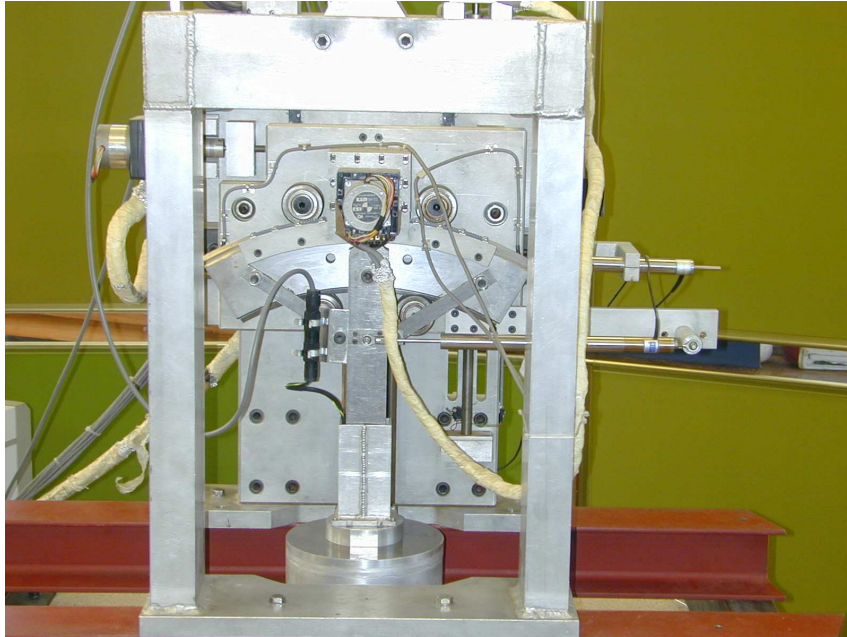**Proposed monopod suction caisson foundation**

Foundations for offshore wind turbines

Why suction caisson foundations?
(for 5MW turbines)

Gravity bases become very large in size and in weight

Piles require expensive equipment and long time for installation
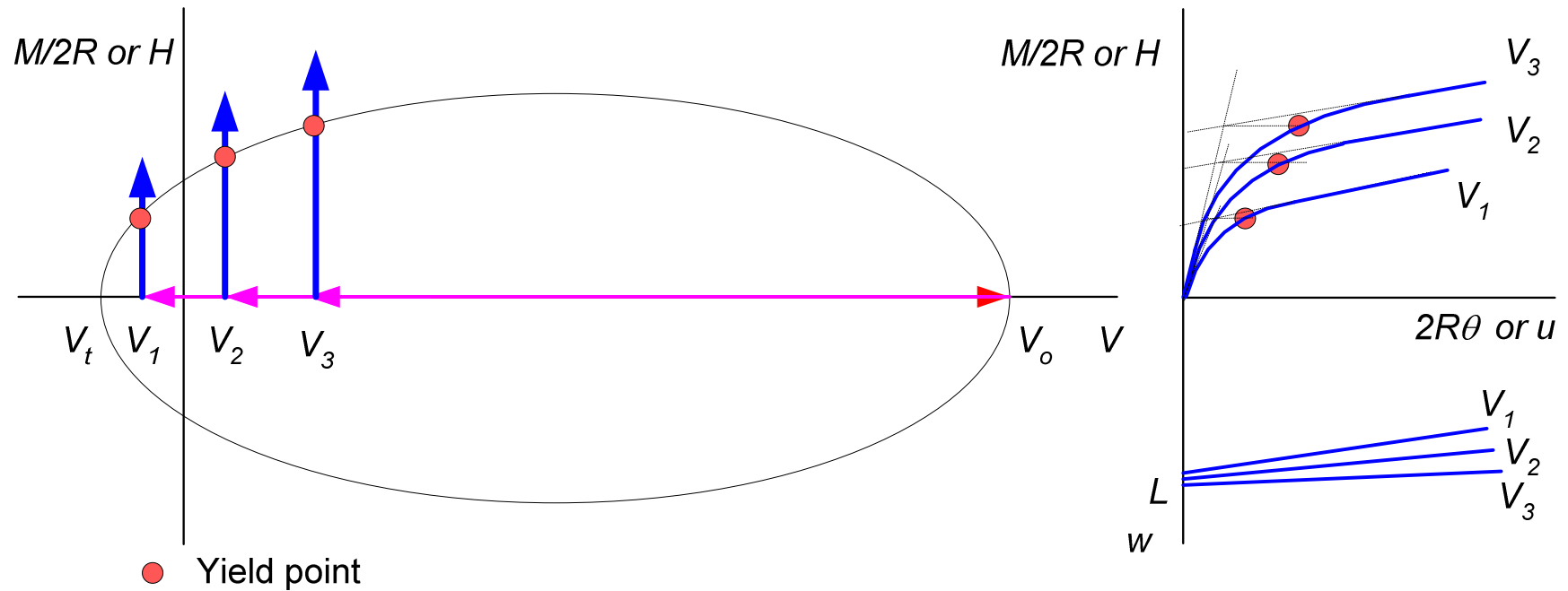
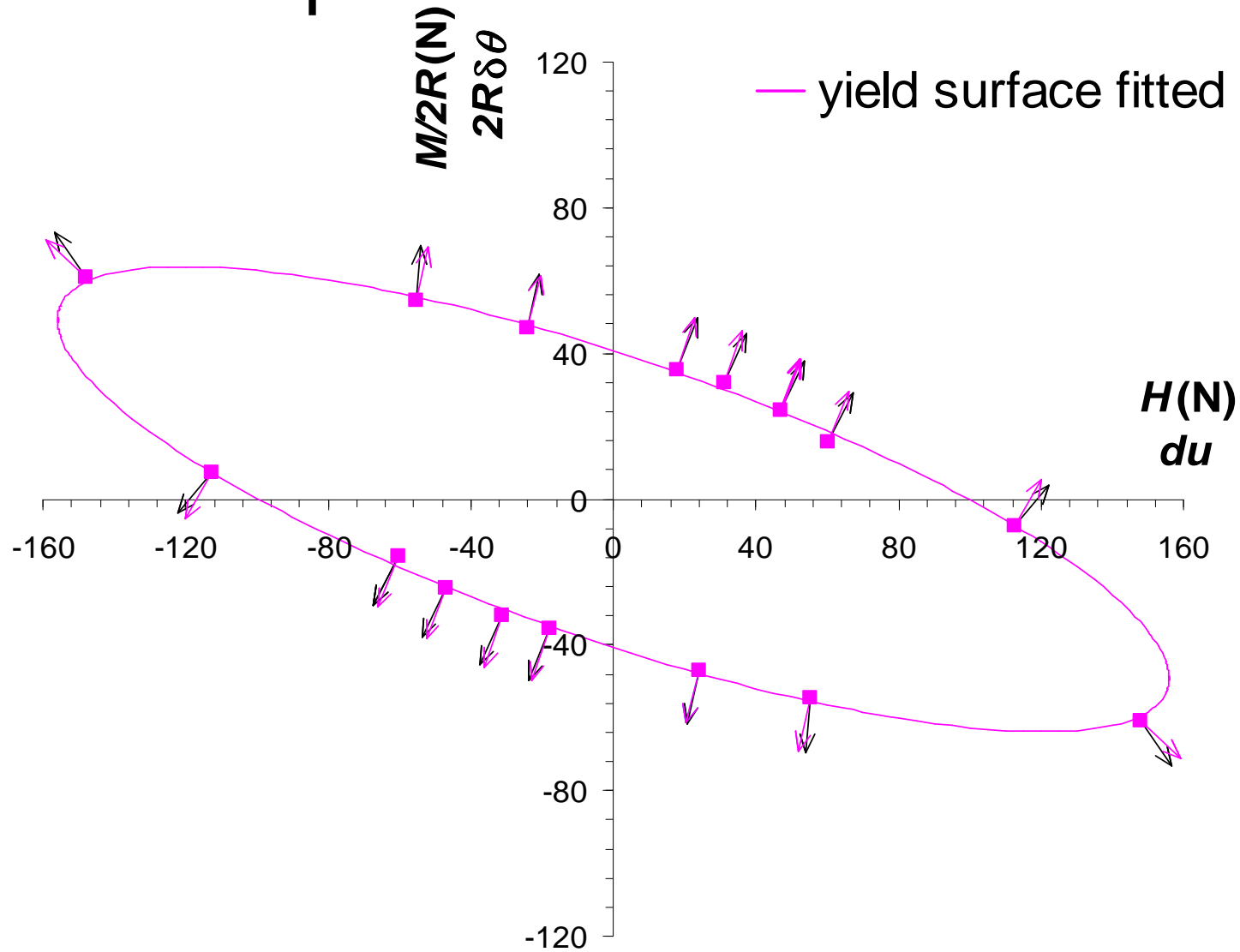# RESEARCH PROGRAMME

Lab tests: 3DOF rig

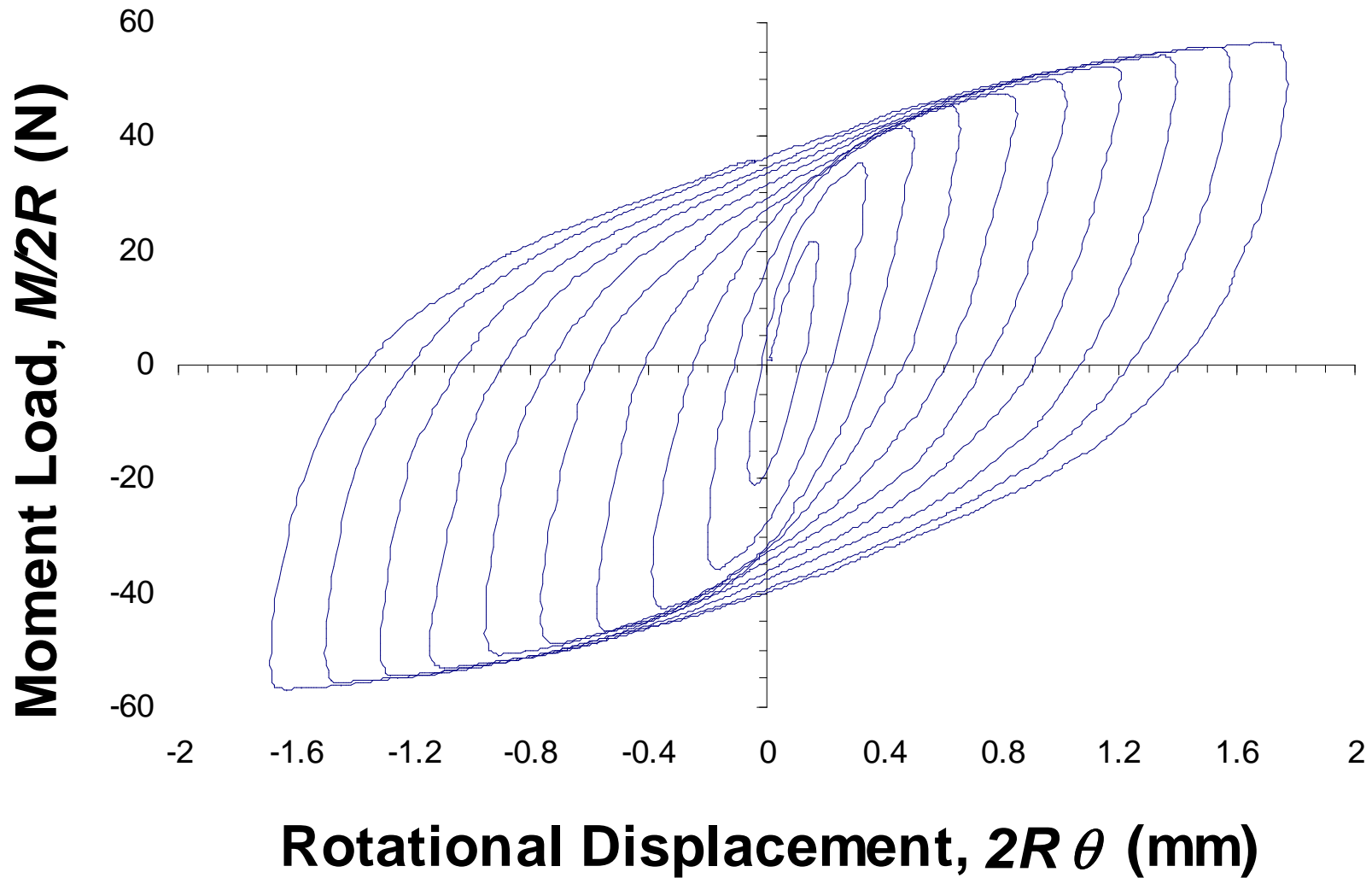Field tests: Reaction frame

Load paths for monotonic loading tests

● Yield point

$$y=\left(\frac{H}{h_oV_o}\right)^2+\left(\frac{M}{2Rm_bV_o}\right)^2-2a\left(\frac{H}{h_oV_o}\right)\left(\frac{M}{2Rm_bV_o}\right)-\left(\frac{\beta_{12}}{\left(t_o+1\right)^{(\beta_1+\beta_2)}}\right)^2\left(\frac{V}{V_o}+t_o\right)^{2\beta_1}\left(1-\frac{V}{V_o}\right)^{2\beta_2}=0$$

Yield points and flow vectors

$M/2R(\text{N})$ $2R\delta\theta$

120

— yield surface fitted

80

$H(\text{N})$
du

40

0

-160   -120   -80   -40   0   40   80   120   160

-40

-80

-120

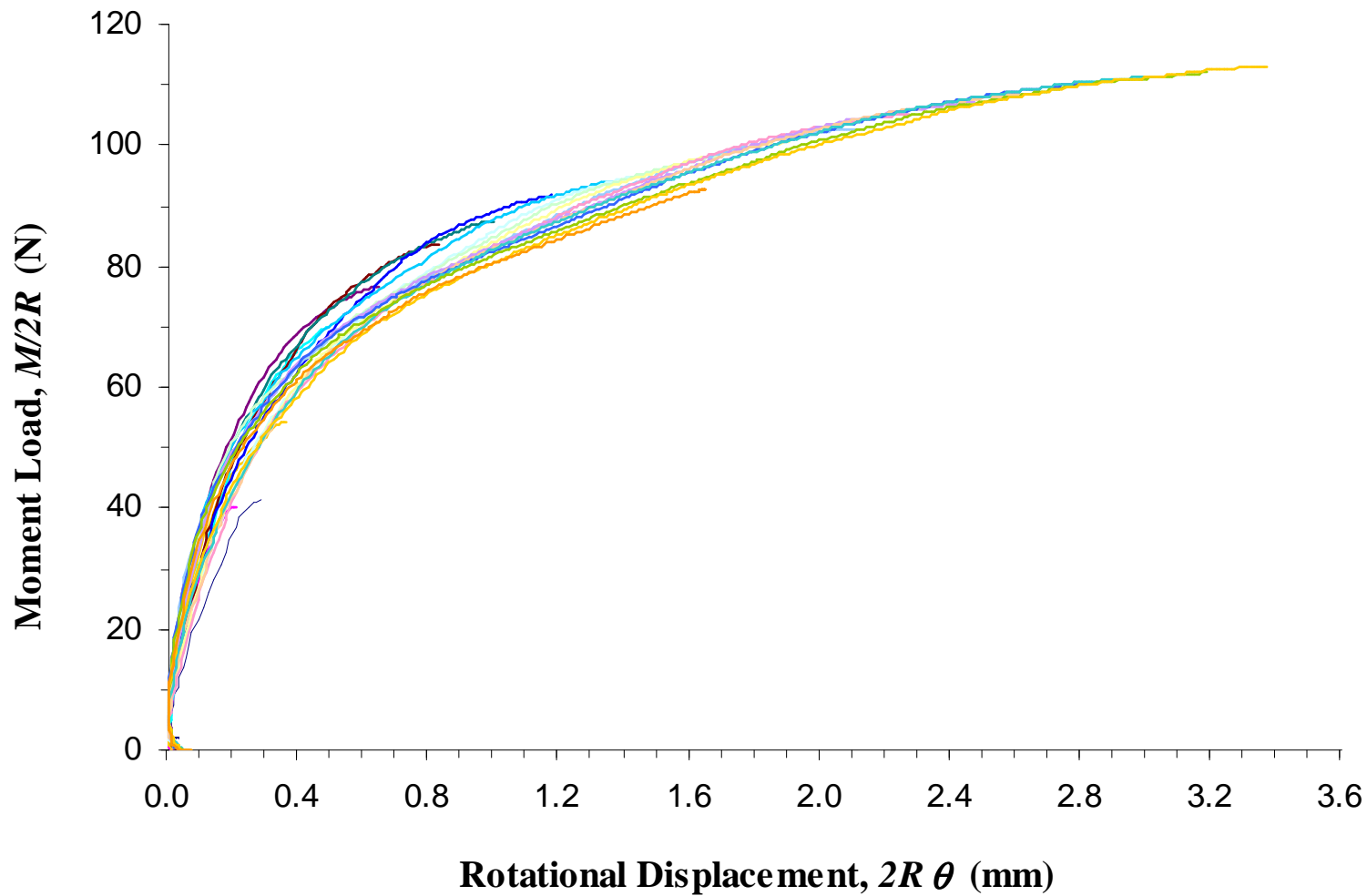Experimental and associated flow vectors, V = 20N and L/D = 0.5

Cyclic tests

Hysteretic response

Masing rule:

i) the shape of the unloading and reloading curves is the same as that of the doubled initial curve

ii) the tangent slope of the reloading curves is identical to the tangent slope of the initial curve

Proof of the Masing rule

Answers

- Higher moment resistance obtained when V was increased

- Evidence of uplift if the caisson is under a certain critical value of vertical load V

- Associated flow rule observed in the $M/2R\text{-}H$ plane

- Proof of the Masing rules

- Results to be used in the construction of a continuous hyperplasticity model

Modelling Questions

- Are the 4 components enough? G, D

- How is the pore pressure effect included in the model?

- How do we interpret this one point model in terms of a physical mechanism?

Construction Questions

- Is going to be that fast and cheap compared with piles?

- Can scour change the design?

- Can the pore pressure build up induced by waves be significant ?

Energy Question

- UK government renewable energy target:

  10% of electricity by 2010 from clean energy $(6 \cdot 10^3 \text{MW})$