Rigid and flexible yaw manoeuvres

1 INTRODUCTION

The yaw bearing is represented by a single rotational degree of freedom called a "hinge". This hinge is illustrated with a diamond shape in Figure 1-1.

The action of the yaw actuator on the hinge can be simulated in two ways.

For "Rigid Yaw", the acceleration of the hinge degree of freedom is *prescribed*. This means that the acceleration is calculated and then imposed on the structural model.

For "Flexible Yaw", yaw motion is achieved by applying equal and opposite torques across the hinge degree of freedom, to represent the torque applied by a yaw actuator.

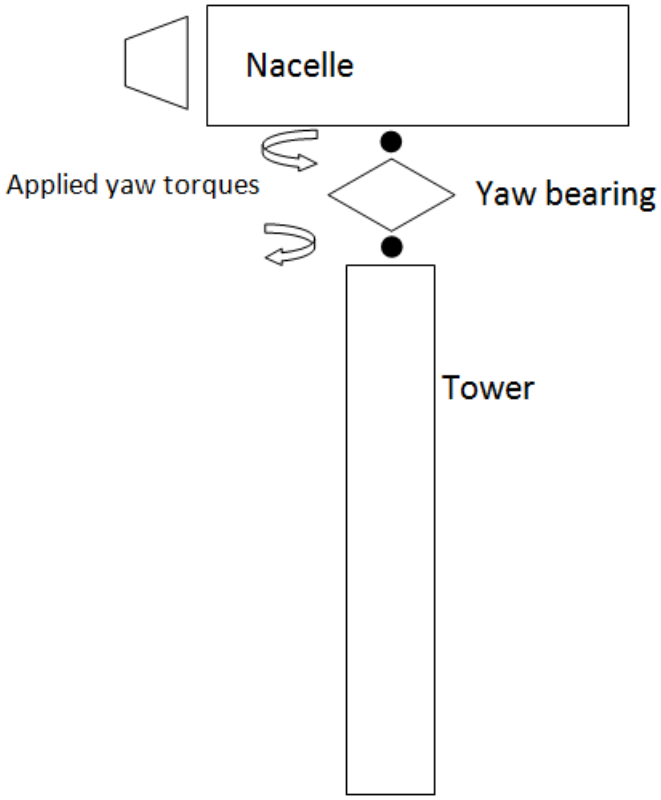

Figure 1-1: Schematic of Bladed yaw actuator modelling

2 RIGID YAW

For "Rigid Yaw", the acceleration of the hinge degree of freedom is *prescribed*. This means that the acceleration is calculated and then imposed on the structural model. The acceleration is calculated by considering the difference between the demanded yaw rate and the actual yaw rate. This is illustrated for a yaw "prescribed manoeuvre" below.

The actual yaw rate and position result from integrating the yaw acceleration at each time step. The actual yaw rate and position will lag slightly behind the demanded yaw rate and position.

The yaw actuator torque can is calculated according to the following relationship

Yaw actuator torque = Yaw Bearing Mz - friction torque

For the case of "Rigid Yaw" without a prescribed manoeuvre, the demanded yaw position will be equal to the initial yaw position (usually zero). If the yaw drive starts to move due to applied forces, a prescribed yaw acceleration will be calculated to bring the yaw drive back to its original position.

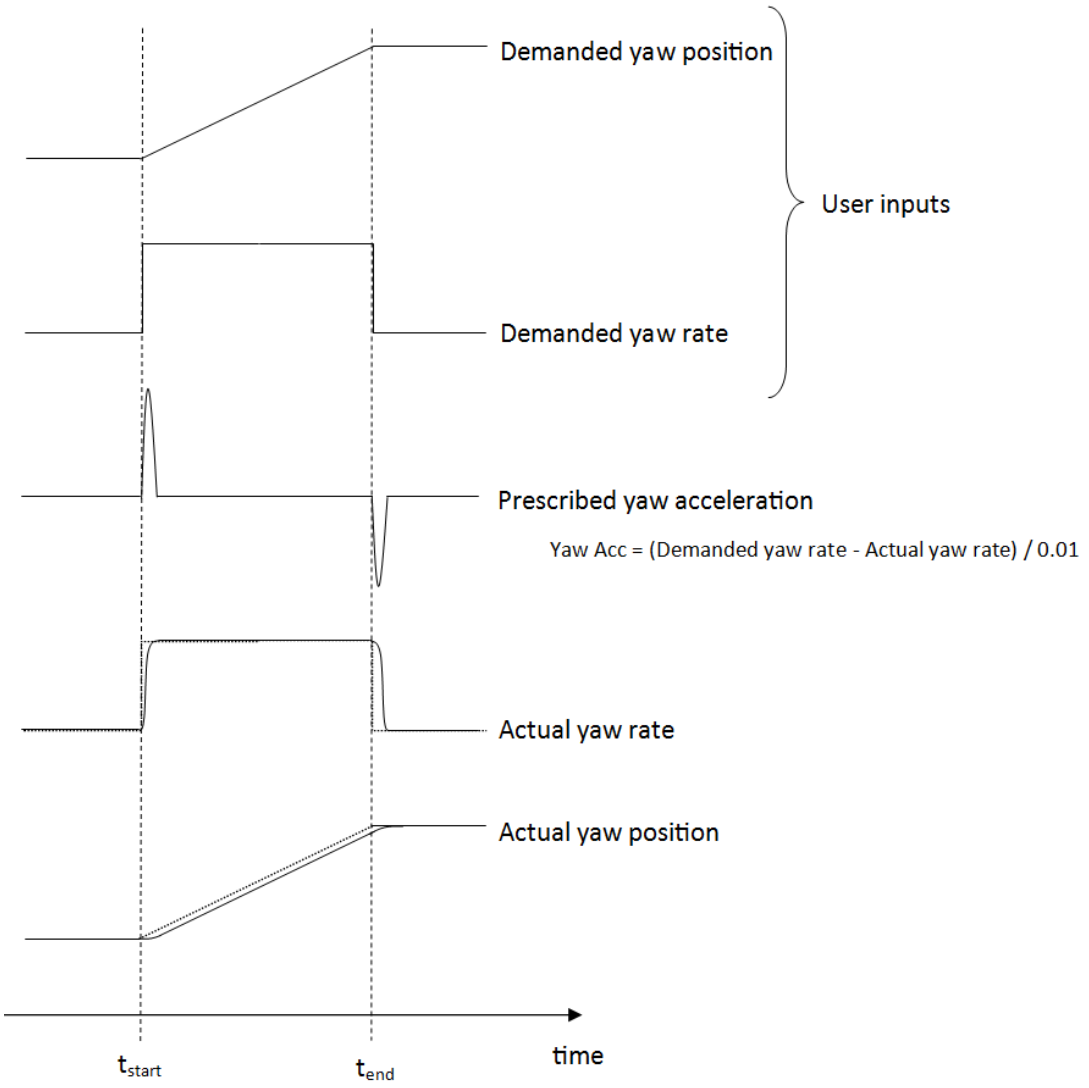

Figure 2-1: Rigid yaw inputs and outputs

3 FLEXIBLE YAW

For "Flexible Yaw", the demanded yaw position and rate are again specified by the user. These demanded values are compared to the actual values and used to calculate the torque to apply across the hinge, according to yaw drive stiffness and damping.

Torque = (Actual yaw position - Demanded yaw position) $*K_{yaw}$
+(Actual yaw velocity - Demanded yaw velocity) * C_{yaw}

The torque applied across the hinge causes an acceleration in the hinge.

For the case of "Flexible Yaw" without a specified yaw manoeuvre, the demanded yaw position will be equal to the initial yaw position (usually zero). If the yaw drive starts to move due to applied forces, a a yaw torque will be calculated and applied to bring the yaw drive back to its original position.

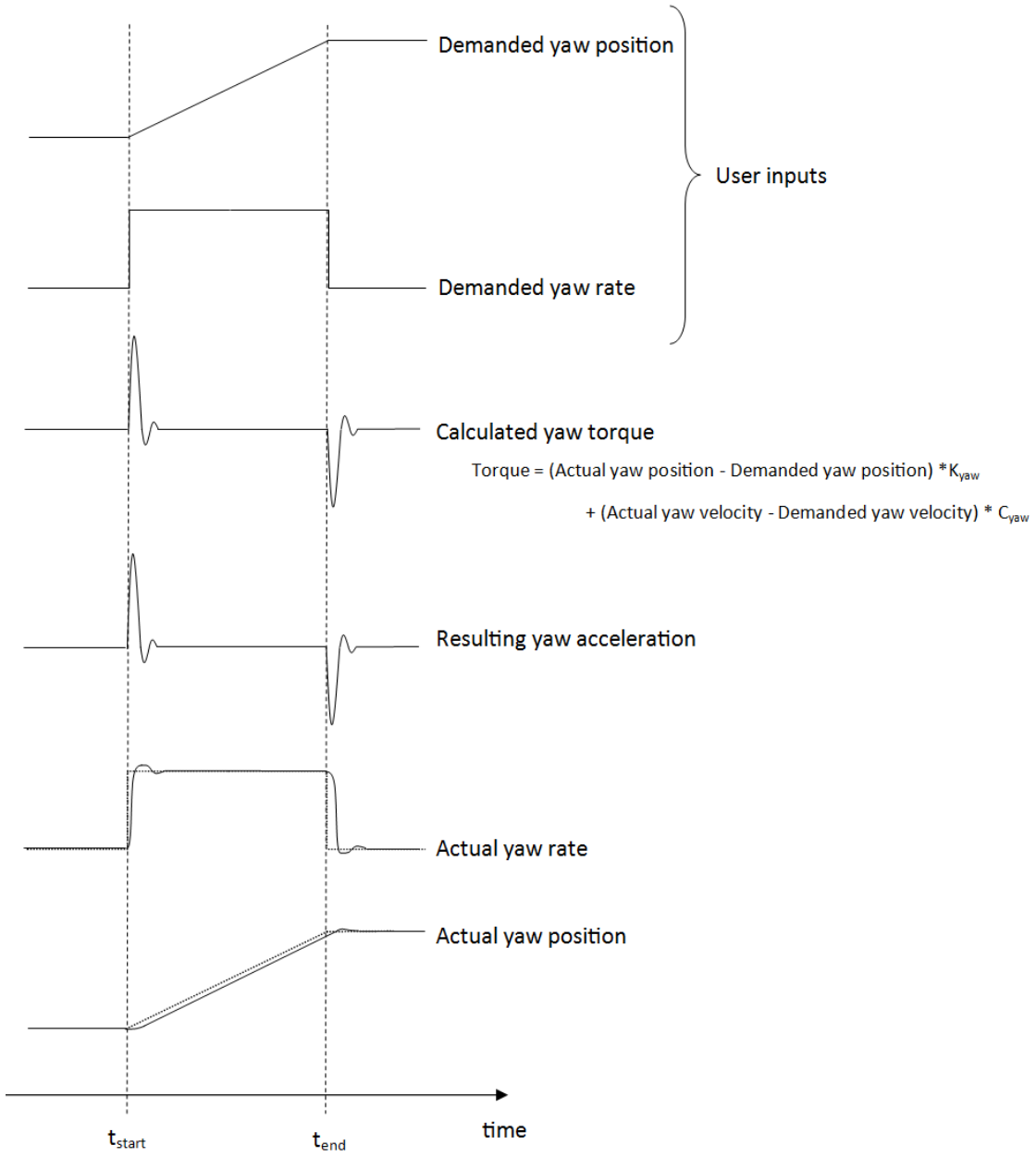

Figure 3-1: Flexible yaw inputs and outputs