Buffet Loads in high performing aircrafts are often dimensioning loads. Their knowledge is therefore mandatory in order to prevent in-service loads exceedance. Unfortunately their simulation is difficult because they depend on dynamic characteristics of airframe and above all by random unsteadiness in aerodynamic flow field impinging the buffeting item. This second aspect makes buffet simulation hard to perform. On the other hand buffet simulation, especially if performed in time domain, provides all data required by stress department to verify structural strength. Loads and Aeroelasticity team in Leonardo Aircraft division believes that an hybrid approach based on inflight accelerometric measurements and airframe digital twin can achieved the desired results, even not knowing the aerodynamic input unsteadiness.

Referring to M345 basic training aircraft, this article collects main activity performed by LAD with the aim of provide a set of deformed shapes of severely buffeting elevator impinged by wing wake in high angle of attack condition. Deformed shapes here proposed have been selected among the time history of airframe random dynamics as those most significant for structural purpose.

The approach here proposed provides a least square regression of structural modes in frequency domain matching inflight data. Analysis of PSD and cross-PSD of inflight acquired accelerometers allows to select normal modes most involved in the dynamics among those calculated by airframe digital twin with an higher MAC coefficient. Acceleration PSDs of digital twin at accelerometers location is obtained believing that each modal coordinate PSD is the result of a second order shape filter having the modal parameters and white noise as input signals.

$$\underline{\underline{PSD_{gg}^{Acce}(\omega)}} = \underline{\underline{\Phi}} \cdot \underline{\underline{PSD_{mm}^{Disp}(\omega)}} \cdot \omega^4 \cdot \underline{\underline{\Phi^T}}$$

$$\underline{\underline{PSD_{mm}^{Disp}(\omega)}} = c\, S_f(\omega) n\, n^T\, S_f(\omega)^T c^T$$

$$\underline{\underline{S_f(\omega)}} = \frac{1}{1 - \frac{w^2}{wn^2} + 2\xi \frac{w}{wn}}$$

Coefficients of each mode participation are defined solving a least square regression between inflight PSD and digital twin prediction.

$$c = (A^T A)^{-1} A^T PSD_{gg}^{flight}(\omega)$$

$$A = \underline{\underline{\Phi}} \cdot \underline{\underline{PSD_{mm}^{Disp}(\omega)}} \cdot \omega^4 \cdot \underline{\underline{\Phi^T}}$$

Regression allows to defines mode shape combination which best match all accelerations PSD at most significant frequency. Time histories of modal coordinates here defined allow to reproduce item dynamics in terms of nodal displacements and internal loads by a direct load recovery using analytical stiffness matrix. Most significant instants, i.e. those maximizing deformation or loads, are selected and shape is provided to stress department in terms of displacement DLOAD.