ADVANCED LANDING GEAR
FATIGUE TEST METHOD

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The technology of landing gear fatigue test used so far has originated from very simplified imitation of partially estimated and partially measured operational load spectra.

- Test stand designed in the 60s of the last century.
- Load applied into the landing gear in a quasi static way.
- Method occasionally complemented by repeated drop test for limit kinetic energy absorption.
- Load correlation between repeated dropping and actually service load condition was low.
Nowadays only the digitally controlled servo hydraulic systems are used world wide in full scale fatigue tests. They simulate random loading of landing gear by flight by flight method.

Landing gear is one of most loaded parts of aircraft:
- Various runways
- Various take off and landing aircraft weights
- Various weather and climatic conditions
- Experienced or beginning pilots
- Most of these input parameters have random character.

Principle of progressive fatigue tests of landing gear is realistic simulation of load spectrum obtained in service.
- Operational load spectrum is created by blocks which represent typical behaviour of aircraft during one flight.
- This spectrum is a source signal that after adaptation is applied into loading system.
- It excites by servo hydraulic actuators in relevant places stress response corresponding to real condition
Design solution of test assembly

• The attachment of landing gear to upper grill structure was designed as inflexible.

• The unit with undercarriage was hanged in test structure through massive swivel bearing.

• Main loading forces were applied into wheel axis through rigid wheel mock-up in place of tire ground touch.

• Dynamic tire radius was taken into consideration.

• Loading through IST digital load system with Labtronic 8080 control system, was designed as two channel one due to linear relation between vertical and fore and aft forces. Fore and aft force was possible simulate by vertical one.

• Upper grill structure was assembled from elements of test building set. It provides sufficient system rigidity.
Design solution of test assembly
CAD and CAE support

Swivel bearing fixture

Nose landing gear CAD model
Operational load measurement

- Nose and main landing gear were fitted with strain gages.
- The program of typical flight was determined.
- Two aeroplane weight configurations were selected with on paved [concrete] and unpaved [grass] runway operation.
- L-410 UVP VZLU commuter was equipped by steering deflection and velocity sensors.
- BMC multi channel data acquisition system with Next-View software were used.
Steering deflection measurement

Nose gear stress measurement
Nose gear stress measurement

On board data acquisition
Frequency response function
Modal analysis of landing gear
Spring and dumping characteristics determination
Stress response evaluation
Tasks:

- Frequency response functions calculation from modal parameters and conversion of modal dynamic behaviour model into frequency response function matrix.

- Detailed experimental modal analysis of landing gear. From modal shapes it is shown how and in what direction parts of landing gear oscillate. That information helps explain causes of increased stress by some frequencies of structure loading.

- To develop how compose the frequency response function of landing gear with respect to its nonlinear properties.
Resonance curves
wheel axis deflection
evaluation-comparison

Modal exciting
Evaluated and measured values of
frequency response function comparison
Spring and damper characteristics determination

courtesy of Mr. Patocka
Input data for modeling

courtesy of Mr. Patocka

geometry and property

load
Comparison of simulation to measurement
courtesy of Mr. Patocka
Stress distribution
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**Load sequence**

- Representative loading of landing gear in certain places for individual ground motions were used.
- Data blocks were generated in SW system LMS TecWare using rain flow algorithm for signal decomposition and reconstruction.
- Data blocks were reduced by amplitudes lesser than one half of fatigue limit. Reduction was made with respect to point to which the iteration of control signal is made. Stress analysis of critical points using formerly determined frequency response function and formerly created model of landing gear in ADAMS software was provided.
- Created data blocks were processed by LMS TWR SW program and during iteration process data files were generated for actuators control.
- By composing these control data files data blocks were compiled representing fatigue test segment. By repeated replaying of these segments the fatigue test itself is run.
Load sequence

Measured data – taxiing, concrete

Reduced data – taxiing, concrete
Control signals for actuators – After TWR iteration
Thank you

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