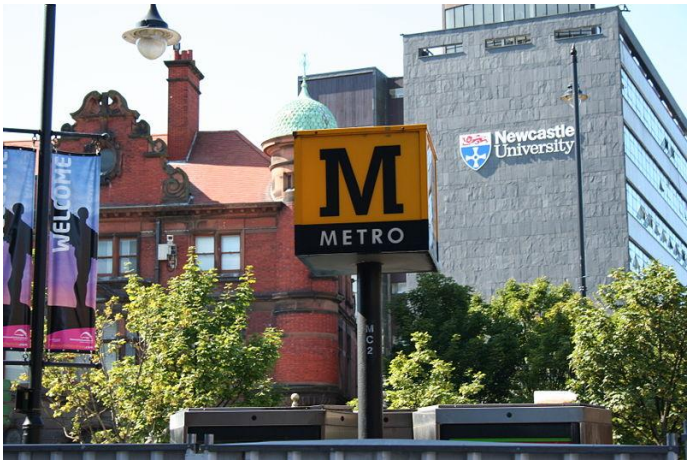
Case Study

Nexus

Escalator Step Analysis

Company Profile

Nexus is the Tyne and Wear Passenger Transport Executive and provides plans and promotes public transport to improve the economic prosperity of Tyne and Wear, and the daily lives of its people. They are looking to the future to create travel networks that the people of Tyne and Wear will want to use in decades to come.



Nexus's plans include a £600m project to modernise the Metro, to create a network of Superoutes with modern accessible buses running on the main traffic corridors, and speeding journey times into the urban centres of Newcastle and Sunderland.

Nexus's aim is to improve the quality of life and fortunes of everyone in Tyne and Wear, by creating better transport networks.

Background

The Metro is a rapid transit railway system, forming part of the transport network governed by Nexus. Several of the 60 Metro Stations are underground and have escalators installed to access platforms or street level.

Nexus required Finite Element Analyses to be carried out on 2 designs of escalator steps; a die-cast and fabricated design to be analysed, to determine stress levels and the fatigue life of the steps under the load cases defined in BS EN 115 : 1995 - Safety Rules for the Construction and Installation of Escalators and Passenger Conveyors. From this, the fitness for purpose of the steps could be determined.

Analysis

IDAC were required by Nexus to carry out an FE analysis to determine the stress levels and fatigue life of 2 step designs, in accordance with BS EN 115: 1995. Finite element analyses were performed to test the escalator steps under a range of working loads, including passenger and torsional loading. Fatigue assessments were then carried out.

IDAC, Airport House, Purley Way, Croydon, Surrey, CR0 0XZ, England
Tel: +44 (0)844 212 5900 **Fax:** +44 (0)844 212 5910
Email: info@idac.co.uk **Homepage:** www.idac.co.uk

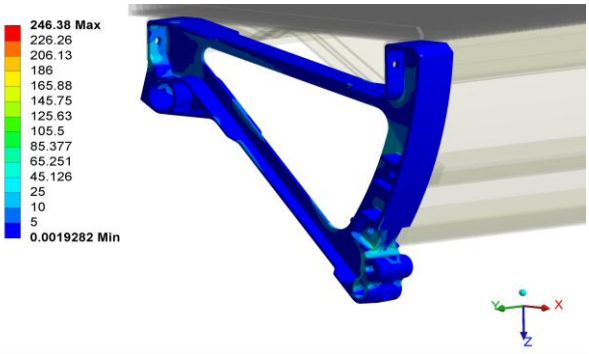
The following load and support cases were modelled:

1. Concentrated load static test (level supports)
2. Concentrated load static test (supports inclined at 30°)
3. Distributed load static test
4. Concentrated dynamic test (supports inclined at 30°)
5. Torsional dynamic test
6. Vandal load test using level support

The models used were three dimensional linear static models, meshed with higher order tetrahedral and hexahedral elements. The mesh was refined in locations of high stresses and regions of interest. All load cases were carried out on a full model of both steps and self weight was included. Stress and displacement plots of the steps were produced to illustrate the response of the step under various loadings.

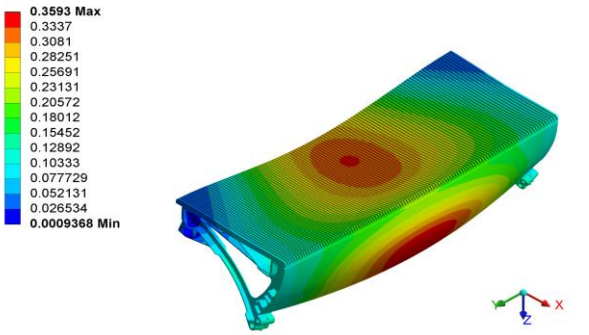
The torsional test and vandal load tests both highlighted some areas for further investigation.

When subjected to a concentrated load with both inclined and level supports a peak compressive stress was found to be located at a fillet of the aluminium cast A-frame support near the wheel pin. This was the same for the distributed load case as well.



For the fatigue analysis the number of cycles to failure was evaluated using the maximum compressive principal range from the 500N and 3000N concentrated load cases (inclined support) and the S-N curve for an A-frame casting obtained from ANSYS. The number of cycles to failure for the fabricated step was based on the static condition only and resulted in a number of cycles of 1.88E9 which exceeded the required $5x10^6$, as defined in BS EN 115-1, 2008. However the number of cycles to failure for the die-cast step was less than $5x10^6$ cycles.

For all cases, the maximum displacement of the step was less than 4mm, satisfying part of the requirements from BS EN 115-1, 2008. The graphic to the right shows one such displacement contour plot.



Design Benefit

IDAC carried out analyses on a die-cast and fabricated escalator step, from this the client was able to ascertain how the steps would behave when exposed to the same loading conditions.

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Email: info@idac.co.uk **Homepage:** www.idac.co.uk