Mobilità sicura e sostenibile
Safe mobility

DII research group
Machine Design, Sports & Rehabilitation Engineering

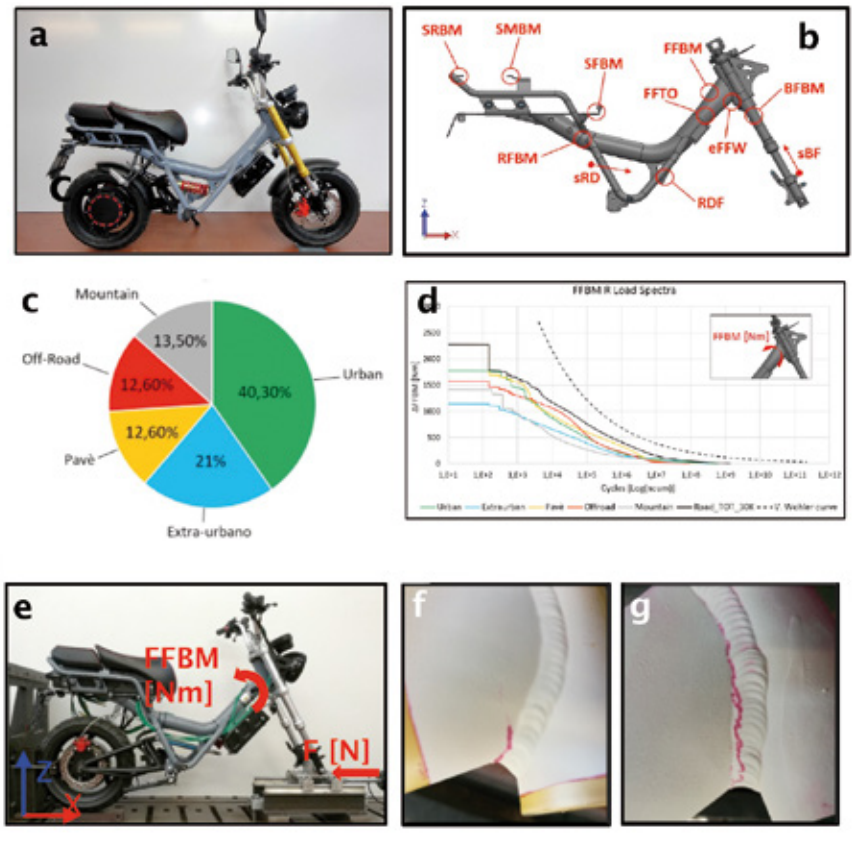
Nicola Petrone
nicola.petrone@unipd.it
+39 049 8276761

Main research topics

- Development of numerical and experimental methods for the evaluation of the structural integrity of components and mechanical structures
- Mechanical characterization static and fatigue of metallic materials and polymeric
- Development of local approaches for structural analysis and fatigue design of components and structures weakened by the effects of geometric carving
- Development of methods for the analysis and design for sports equipment and rehabilitation

Structural analysis and fatigue life prediction of electric lightweight moped frames

Structural design of lightweight vehicles is becoming more and more urgent after the increased popularity of electrical vehicles that includes also small mopeds (Figure a) with engine at the rear wheel hub and battery pack below the saddle. The study addressed the field load spectra collection and the laboratory fatigue testing of such a prototype, to be introduced in the market in the next months. The moped was instrumented with eleven strain gauges bridges and two linear potentiometers as shown in Figure b. After laboratory calibration of each channel, a road data collection campaign was carried out in order to explore the road mix shown in Figure c. Two channels were assumed to represent the main loads acting on the frame: FFBM as the bending moment at the front main tube, and RFBM as the Bending moment at the rear main tube. Load spectra from the different surfaces were obtained after rainflow counting of time histories, extended to the mission life of 30k km and combined in order to estimate the minimum Wohler curve needed to survive the assumed mission life (Figure d). A set of prototype frames underwent frontal horizontal fatigue tests as in Figure e and vertical fatigue with load applied to the saddle. As a result, fatigue cracks developed at the weld toe (Figure f) or at the weld root (Figure g) of the joint between main tube and steering tube, requiring the reinforcement of the frame structure and enabling the achievement of the desired life of the final product.



Figures. a) Electric moped analysed. b) Channels of the instrumented moped. c) Road mix collected. d) Field load spectrum and virtual Wohler curve. e) Horizontal Fatigue tests. f) Weld toe crack. g) weld root crack.