EUROTEST - A PROJECT FOR IDENTIFYING THE HANDLING HAZARDS AND DEVELOPING NEW TEST METHODS

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ABSTRACT

A large ongoing Eureka project will be described with some of its results. The project, EUROTEST is aiming, among other things, for developing new, improved test methods, with the wider scope of reducing damage caused by loading and unloading of goods during terminals handling.

The project has used modern sensor technology applications to collect the distribution environment.

The process of developing new test and dimensioning methods for packaging from these field tests for mechanical and manual handling will be described. In that process measuring routines, test protocols, analysis and analysis summaries have been developed, which will be described and discussed.

Relevant factors for cargo handling, such as
- drop height in relation to mechanical and manual handling
- drop height in relation to weight/size/type of goods
- shock levels occurring for different products and different destinations

will be described and discussed.

Also methods for abrasion resistance of packages due to vibrations will be discussed.

Keywords: test methods, mechanical handling, manual handling, transportation, packaging, drop height, shock, vibration

1. Introduction

This paper presents the ideas and some results from the ongoing Eureka project "EUROTEST – Test Methods for Product Protection during Distribution within Europe."

A full project description is easily available on www.eureka.be, by giving project number 2606 or the acronym EUROTEST.

2. Background

The manufacturing industry is facing several challenges. The often long delivery distances with several re-loading points and border crossings cause very high costs and risks for damage or hazards during handling. Much damage occurs during distribution, in terminals with loading and unloading of the goods, but also during the transport itself.

A large European project, SRETS, (reference 1), has estimated current damage costs to approximately 3 billion Euro/year for the goods owners within the EU. Since the distribution systems are constantly changing, and damage costs have remained high, it has become necessary to investigate this matter. The increased use in some countries of Internet shopping also puts a higher demand for utilisation of alternative distribution channels and more frequent sendings. By mapping the types of damages, estimated damage rates and the actual handling involved, efficient countermeasures can be taken.

Increased international competition, customers' zero-defect demands together with varying demands from different markets make this project especially urgent as an independent source of knowledge to ensure growth or guarantee survival for the manufacturing and electronics industries.

The project fits quite well in the vision of combining product development and packaging development where elements from the real environment (in this case the distribution environment) and the laboratory test methods are matched according to Figure 1.

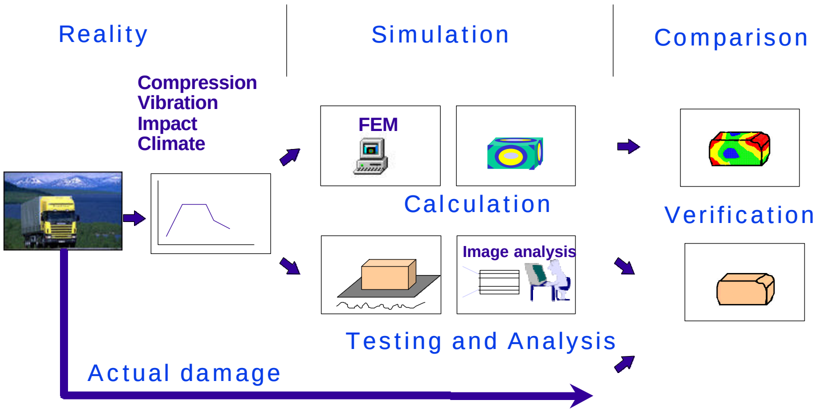

Figure 1. Interaction between measurement, calculation, testing and analysis

3. Measurements

3.1 General considerations

A number of alternative products have been equipped with a recording device, so called SAVER™ (Shock and Vibration Environment Recorder) for measuring the actual transportation and handling environment (ref.2). The instrument measures the acceleration levels in three perpendicular directions; predetermined by connecting the instrument to a PC and setting the instrument parameters. Also temperature and relative humidity values are, as a bonus, sampled throughout the transportation chain.
In order to develop good measuring routines a number of activities had to be done. Several guidelines have been produced, since the instrument manufacturer did not have this type of descriptions. One guide was produced to use the Saver in an adequate way, choosing the appropriate triggering levels, pre trigging times (telling what free fall drop heights can be measured) and so forth. Also the handling of the large amounts of data resulting from following different transportation chains has been elaborated as guide lines for analysis.

In order to better analyse the data amounts to draw the right conclusions, terminal studies have also been done. For this purpose a terminals check list was developed. Also, in order to try to correlate specific events, for example throws, tumbling and sliding of packages, package-to-package colllisions etc a number of controlled laboratory tests have been done.

All the measurements which have taken place followed the "DIN 30786-30787 – philosophy" (ref 3-4), meaning in short that measurements and analyses will have higher quality the better documented the measurements are. During all measurements it is also better to notify "too much than too little". In the "real world" it has sometimes been difficult to communicate this message to persons in companies or terminals. All the measurements have been done "covert", meaning that no drivers or terminal persons have known that the cargo was equipped with shock recorder. This is very essential in order to get realistic data.

3.2 Measurement case – Bindomatic masterboxes

A series of measurements was done for Bindomatic AB, who make document finishing systems, such as document binders, automatic or manual, as well as materials, covers for binding of papers in reports, manuals etc.

Below is the example where so called Master boxes were equipped with the measuring device and monitored on routes between head office in Stockholm, Sweden and Fatima, Portugal where the covers are manufactured. Each "Master Box " is a single item corrugated cardboard non-palletised box containing around 1500 covers, depending of cover quality, in three separate cassettes. The cassettes, also in corrugated cardboard, is put directly in the larger machines for document finishing. The weight of the Masterbox is 15.5kg to 16.4kg (std covers), and the outside dimensions 400*440*325mm . In our trials the content in the middle cassette was replaced with a Saver as can be seen in Figures 2 and 3. The weight and dimensions of the instrumented packages were the same as the original ones.
A number of consecutive sendings, on separate days, with "normal routines" were then done between Sweden and Portugal, meaning DHL as a carrier from Sweden and TNT as a carrier from Portugal. For the project we had three Savers available. In order to make the evaluation easier a series of test protocols were developed. The available tracking service, giving the freight number, on the Internet have been used in order to enrichen the analysis. Also the package contained extra fresh batteries with the intent at delivery to replace old batteries, downloading data and once again start the instrument to make new measurements on the return trip.

Figure 2   Masterbox for preparation

Figure 3. Modified content of one cassette

In Figures 4 and 5 there are only a very few examples of the vast collected data shown. Figure 4 illustrates that for a single package, not unitised or pallet load, any direction could be the “drop direction”. In this case the box has a natural up and down side and most of the highest acceleration values occur in the vertical direction, although as can be seen the ranking order is not 100 % according to dominant direction.
In Figure 5 is illustrated the well known fact that the choice of sampling frequencies/filter frequencies determine what maximum values you get. The software lowpass filter was for the same data set to either 200, 64 or 32 Hz. The specific application has to decide filter type and in this case, where a transportation chain is monitored, it could for example be varied as in Figure 5. The damage mechanisms together with distribution characteristics will influence and decide the filters used. The very important thing is, when comparing for example different distributor’s handling/transportation, that the same measure, sampling frequency and filter frequency are used.

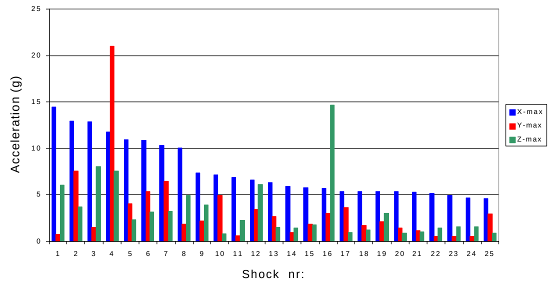

Figure 4. The 25 largest acceleration values sorted after the main direction.

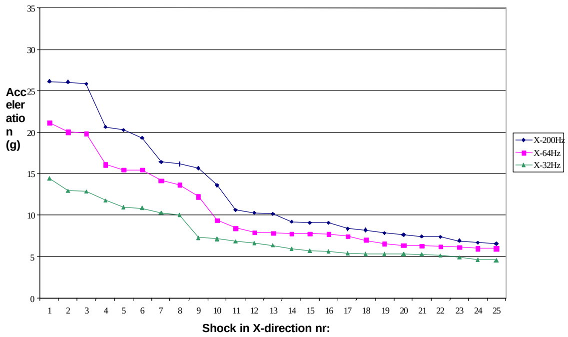

Figure 5. The 25 largest values, filtered with lowpass filters with 200 Hz, 64 Hz and 32 Hz.

3.3 Measurement case – Exploratory controlled measurements

An idea of the project was to identify and separate different types of hazards, especially during handling. The thought of this, is that the number of, as well as the magnitudes of phenomenons, such as sliding of packages, tilting, package-to- package collisions will give a good basis for the development of realistic test methods with realistic test levels.
In order to obtain knowledge of what “package behaviour” in the real world would look like with the shock recorder, a series of controlled laboratory measurements was carried out. Experiments were done both with package drop testers, with manual throwing of packages and even with tests in a staircase, illustrated in Figure 6.

During the test with a package drop tester, it was among other factors found very important how trigger levels and pre trigger times are set, if ”the intelligence” in the evaluation software will be used for detecting drops. Some tedious manipulation of the data was required to correctly describe drop heights for drops from 35, 60 and 75 centimeters. But a useful conclusion was that drops from different drop heights could be used to identify how accurate the test equipment is, or to find and modify imperfections in the test equipment itself, illustrated in Figure 7.

Also a series of corner drops and edge drops was performed. During these circumstances a lot of effort is needed to process and use direction-of-drop-data.

The stair case trials showed that information about drop heights or displacements is not useful, but the shock data itself can be evaluated as illustrated in Figure 8.

Figure 6. Package in stair case

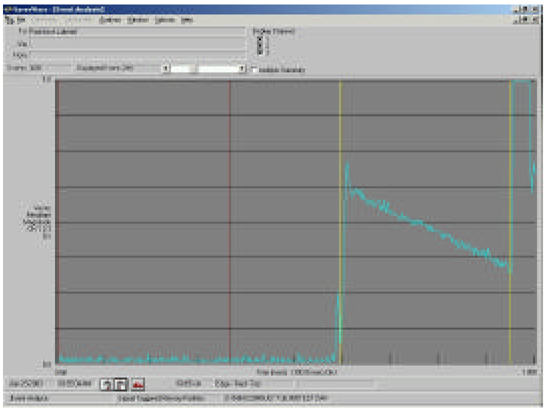

Figure 7. Drop height detection in the Saver.

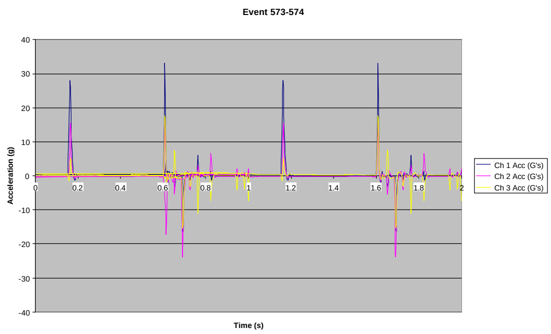

Figure 8. Stair case tumbling.

4. Discussion and conclusions

The project EUROTEST will result in a series of reports describing litterature studies, field studies, analysis and methodology and recommendations for new test methods and severity levels.

A major subject in the project is the handling and administration of the large data sets and large output volumes from different analyses. A lot of effort has been put into this subject in order to develop different types of guidelines and manuals.

Packages can be damaged in different parts of the distribution chain, for instance during transport, storing and handling which all give rise to different stresses such as transient loads, vibrations and long-term, high static loads. One common reason for surface imperfections is the fact that during transport and handling, packages rub and chafe against each other, which results in damaged labels and worn decor print. The EUROTEST project will also try to deal with these new types of concerns which will hopefully be reflected in proposed new and improved test methods. The evaluation of proposed test methods and correlation between the real distribution environment and the test levels of such methods can be investigated by modern optical measuring methods presented in reference 5.

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