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Procedia CIRP 23 (2014) 83 – 88

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Conference on Assembly Technologies and Systems

Single part influence on assemblies for a cycle time able quality control as well as a suitable toleration

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Abstract

The complex interrelations of force and stiffness during the clamping process of freeform shaped parts in car body fixtures cannot be described in a universal valid way by membrane theory. So calculations with FEM are used for this. However due to the long calculating time FEM is not suitable for fast quality decisions during the process. The paper presents a new method that is able to calculate adjustments and combination possibilities of different part failure classes within sub-second range. In addition the new method, that is based on a systematic analyze of the single part influences to the assembly, gives an understanding of the interrelations of all components of an assembly. So a suitable toleration is possible. The method is shown by means of an assembly example.

Keywords: car body, assembly, suitable toleration, shim

1. Introduction

Clamping fixtures are a central element in the car-body construction process. They are instrumental to the quality of the finished product. Whereas joining and handling technologies are already being used in highly flexible and automated ways [1,2], a considerable amount of manual effort is still required to address, in particular, the quality control measures – known as shimming – for fixtures [3]. This process of shimming, which can be defined as the fine adjustment of the positioning of clamping points in response to quality deviations in the sheet metal parts from the press shop, is at present divided into three main work steps:

- The measurement of random samples of joined assemblies
- The decision with regard to quality control measures (shimming dimensions)
- If applicable, the implementation of these quality control measures by means of adjustments made to the fixing points using special adjustment plates (shims)

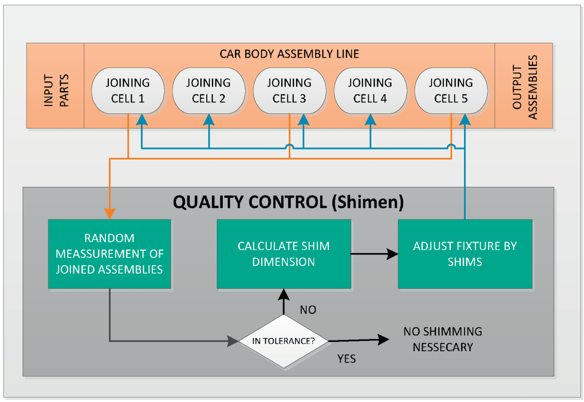

Figure 1: Symbolic representation of the shimming procedure (present-day)

The present-day procedure, as it is also shown in figure 1, is subject to the criticism that the components are not measured until after the joining process. A great deal of time pass-

doi:10.1016/j.procir.2014.10.064

es from the time the sample is extracted until the time when the sample is measured before a decision is made and quality control measures are implemented. Large numbers of additional assemblies are fabricated within that time, possibly with a suboptimal fixture configuration, depending on the circumstances. With this type of quality control, good parts can only be reliably produced when correspondingly narrow tolerance limits are maintained for the input components.

[4] shows a novel method that is capable of calculating shim dimensions on the basis of the actual deformation of the input components. One advantage of this method is that it eliminates the need to maintain tolerance buffers for the delayed quality assessment of the already joined components.

The quality assessment in [4] is performed directly in the joining fixture. It is possible, however, to take the concept of determining the positioning dimensions on the basis of the quality of the input components even further. One alternative configuration would be to measure the input components prior to the car-body construction process. For example, the supplier of the individual sheet metal parts (press shop) could carry out these measurements and include information about the actual component-specific or batch-specific dimensional deviations as part of the delivery.

This recommendation would result in higher quality-management costs at the press shop. The formed parts are already being measured at present. However, the approach described here would require that the measurement results be processed and saved accordingly. This raises the question of whether it is necessary to measure all component types. The immediate assumption is that there are components, of which the quality has a significant influence on the quality of the assembly and others that only exert minimal influence. Significant factors here include the rigidity of the components and their dimensional deviation. Figure 2 shows a schematic prioritisation of this assumption.

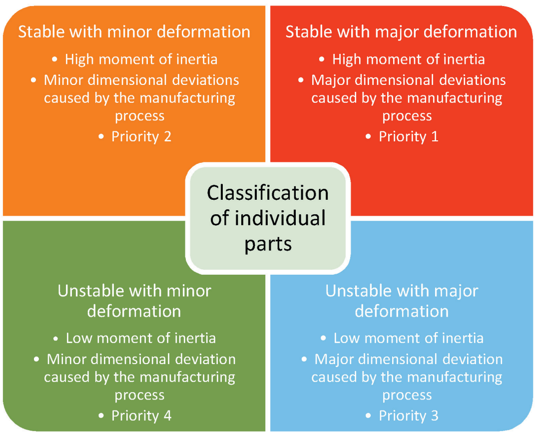

Figure 2: Individual part priorities according to their influence on the quality of the assembly

Therefore, it is essential to decide whether every component must be measured in the press shop. Components of which the dimensional accuracy is crucial to the quality of the assembly should, in any case, be checked. Less important components could, in contrast, be used even without having their dimensional accuracy checked, since they would be forced into the required position in the assembly by the neighbouring joining partners on account of their low rigidity.

To ensure that this decision is well grounded, the influence that the respective individual part has on the assembly must be assessed on the basis of a characteristic value. [5]

2. Determination of the influence of the individual part on the assembly

The following method was used to describe the influence of the individual part. An analysis was carried out on a door assembly, which was chosen as an example. A multi-part CAD model is used for this. The assembly consists of six individual parts, which are very different in terms of their mechanical and geometrical properties. In this paper, assumptions are made regarding the joining processes and the number of joining points, to serve as an example.

Table 1: Constituent parts of the joined assembly

No.	Component	Joining process	Colour
1	Impact reinforcement	RSW*	Yellow
2	Hinge reinforcement	RSW*, adhesive bonding	Red
3	Reinforcement tube	RSW*	Brown
4	Shaft reinforcement	RSW*	Orange
5	Core	RSW*	Green
6	Frame reinforcement	RSW*	Purple

*RSW means Resistance Spot Welding

The door elements defined in Table 1 are illustrated in Figure 3 (left), shown in their geometrical position in the assembly. The outer sheet of the door has been omitted from the assembly for illustrative purposes.

The specified joining processes are compared with various car-body construction data and specified as an example. The joining processes to be used are resistance spot welding and adhesive bonding. The geometric positioning of the joining points used for the RS welding is illustrated in Figure 3 (right).

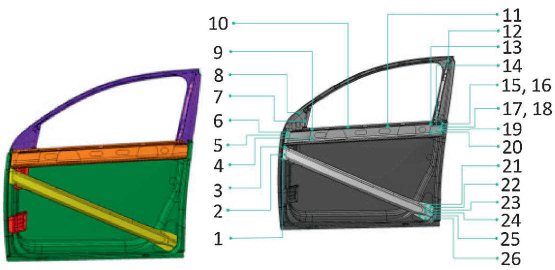

Figure 3: Illustration of door elements (left); joining points (right)