On the design of force-platforms in stabilography

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by

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ON THE DESIGN OF FORCE-PLATFORMS IN STABILOGRAPHY

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In order to obtain a correct determination of the mechanical momentum exerted on the platform of stabilograph, it is proved to be necessary to design a force-platform of such a shape that horizontal forces no longer interfere with the momentum.

The design suggested here, leads to correct measurements of the momentum. The result is that the momentum may differ considerably from that obtained by means of the usual platforms.

In order to obtain a correct determination of the total mechanical momentum exerted by a standing man on a platform of a stabilograph, we have focussed our attention on the problem of constructing an adequate platform.

Though there exist several types of measuring platform, we will restrict ourselves to platforms which are supported by force-transducers (BARIGANT, MERLET *et al.*, 1972; SNIJDERS and VERDUIN, 1973). In Fig. 1 a schematic side view of a platform is shown. M means the mechanical momentum with respect to the anklejoint, which is caused by the person that stands on the platform. F_1, F_2, F_3 and F_4 are the external forces acting on the platform. F_2 and F_3 are the registered reactionforces from the force-transducers, F_1 and F_4 are friction forces and are not measured by the force-transducers.

The relation between the momentum M and the given forces reads :

$$(1) \qquad M = (F_4 - F_1)\, h + F_2(a_1 - b) - F_3(a_2 + b) - m_{pl}\, g\, b,$$

where h is the vertical distance between the anklejoint and the plane in which the bearing points of the force-transducers are located, here the horizontal plane through F_1 and F_4.

In the following we omit the last term of equation (1), because this term is not relevant here. In the static situation i.e. the person on the platform does not move, the value of M can be found from F_2 and F_3 which are measured by the force-transducers, because in the static equilibrium the resultant horizontal force $F_4 - F_1$ is equal to zero.

In the dynamic situation i.e. the person sways around his equilibrium position, the resultant horizontal force $F_4 - F_1$ is not equal to zero anymore (see also KAPTEIJN, 1973). It is clear that, when we use the platform shown in Fig. 1, where $h = e + d$, we cannot determine M by only registering F_2 and F_3.

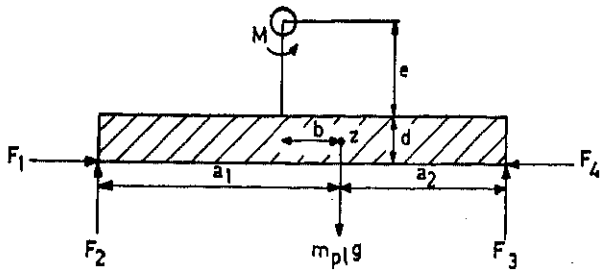

FIGURE 1. — A schematic side view of a usual stabilograph-platform.
Z is the center of gravity of the platform.
m_{pl} is the mass of the platform.
g is the acceleration due to gravity.
a_1 and a_2 are the horizontal distances between Z and the position where the force-transducers are located.
b is the horizontal between Z and the ankle-joint.
d is the thickness of the platform.
e is the vertical distance between the ankle-joint and the top of the platform.
For the meaning of F_1, F_2, F_3, F_4 and M see text.

To cope with this problem, we have designed a platform as shown in a schematic way in Fig. 2. The horizontal force $F_4 - F_1$ does not interfere any longer with the measurement of the momentum M because of the fact that $F_4 - F_1$ acts in the plane through the ankle joint so in equation (1) h = 0. This means that now the values of F_2 and F_3 will result in a correct determination of the momentum M, which is the purpose of the measurements.

Fig. 3 shows a perspective drawing of the platform which is constructed such that h [see (1)] is equal to zero.

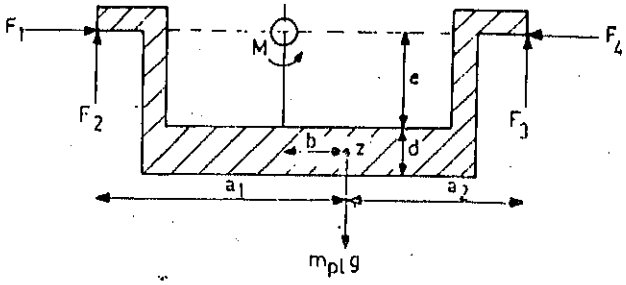

FIGURE 2. — A schematic side view of the newly designed platform. For the meaning of the different quantities see Fig. 1 and text.

Introductary experiments with this platform showed that, although M remained unchanged, when taking the value of h to be 10 cm, the measured values of F_2 and F_3 increased accordingly.

The conclusion is, that it is important to design a platform of such a shape, that it is adapted to the purpose of measuring the momentum M.

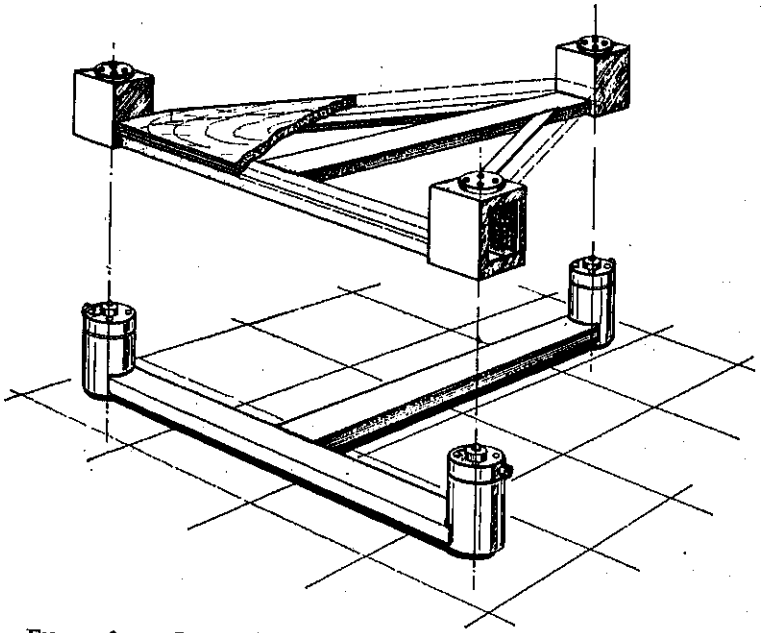

FIGURE 3. — Perspective drawing of the newly designed platform.

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RÉSUMÉ

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A propos du type de plateforme en stabilographie

Pour obtenir une détermination correcte du moment exercée sur la plateforme d'un stabilographe il est prouvé qu'il est nécessaire de concevoir une plateforme d'une forme telle que les forces horizontales n'interfèrent pas avec le moment.

La forme proposée ici conduit à des mesures correctes du moment. Il en résulte que ce moment peut différer considérablement de celui obtenu au moyen des plateformes habituelles.