Some technical aspects of *zenkutsu* stance in karate

Introduction

The zenkutsu dachi stance is a common stance in every martial art from Japan especially when we are talking about martial arts heavily relying on punching and kicking techniques. Many books can be written about technical and historical aspects of this stance but many of these aspects cannot be discussed here. Unfortunately, every karate school has its own description of this stance. Also, points scored during kumite competition depend on what it looks like. The strangest thing is that for many karatekas the zenkutsu from kumite is completely different from the one taken from kata.

The role of zenkutsu dachi as a basic stance

There are two main points in the standard of *zenkutsu dachi*. First is the supporting (back) leg which is depicted as either bent or straight depending on the school. Second parameter is the angle between the supporting leg and floor which, by the way, clearly determines the height of the body position.
Another aspect of zenkutsu dachi is feet alignment. Here, one can also be confused by different approaches. For example, width equal to the hips (or shoulder), double the hips (or shoulder) length of. The most common approach in terms of length is to have the back leg straight.

Fig. 1a
The typical zenkutsu dachi for WKF kata competitors. Back leg is straight and the stance is long.

Fig. 1b
Zenkutsu dachi as a free fight stance. Very short stance with back leg bent, but the lower spine almost straight.

The first question is why do we need stances? There are two main reasons: to deliver energy and to ensure quick start. In zenkutsu dachi the back leg is a source of movement and power. One of the most important things in this stance is to allow the fighter to start his move as fast as it is possible. In order to do this he has to use force. All what he can do is to apply the force F (see Fig.2). This will enable him move along the line of the force, but the fighter wants to move forward (horizontally). The force responsible for moving forward is F_1 which is the element of F. Then F_2 is the second element of F but connected with the pressure on the floor. The correlation between F_1 and F_2 depends on the angle between the leg and the floor.

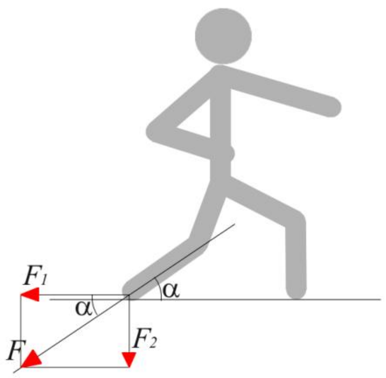

Fig. 2
The forces discussed when applied in zenkutsu dachi as a kumite stance

Every karateka wants the F_1 to be as large as possible but it is known that the F_1 force cannot be unlimited (infinite). The value of this force must be lower or at least equal to the force of friction. If not, the fighter will not be able to move. In this case (F_1=T) we obtain:

$$\cos \propto = \frac{F_1}{F}$$

$$F_1 = F \cos \propto$$

$$\cos \propto = \frac{T}{F} = \frac{\mu F_2}{F} = \mu \frac{F_2}{F} = \mu \sin \propto$$

$$\frac{\cos \propto}{\sin \propto} = \mu$$

$$\text{ctg} \propto = \mu$$

Where T is the force of friction. T depends only on the friction coefficient μ and the pressure F_2. If one assumes that the weight is constant for the fighter than it is possible to see that the friction depends only on the surfaces that are in touch. The smallest μ is for the ice or for the Teflon. It is obvious that moving on slippery surfaces (with small μ) is significantly more difficult. Some of friction coefficients (static friction) are presented in Table1:

Table 1

Materials	coefficient of friction μ
steel-ice	0.02-0.03
wood-skin	0.4-0.6
metal-skin	0.3-0.5
Teflon-Teflon	0.04
steel-steel	0.15

As we can see:

1. the lower the friction (μ), the lower cos α
2. the lower the cos α, the bigger the α
3. the bigger the α, the higher the position
4. $\mu_1 > \mu_2 \Rightarrow \alpha_1 < \alpha_2 \Rightarrow h_1 < h_2$

The conclusion is that the length and height of the stance does not depend on the hips but on the surface the fighter stands on. Zenkutsu dachi performed on ice does not give many possibilities to move. In fact, the bigger angle between the leg and the floor also influences the ratio of the F_2 force and allows to gather the bigger friction according to $T = \mu F_2$

Fig. 3a and Fig. 3b
Zenkustu dachi on different kinds of surfaces. The μ coefficient on Fig 3a is greater than that on Fig 3b. Note that the higher position corresponds to the more slippery surface so the F_1 applied by Fig3a fighter can be bigger than used by the fighter from Fig3b . The reason is that the force F_1 cannot by greater than the friction force T. The length of the back leg is the same on the both pictures. Note also different ratios between the horizontal and vertical side of the rectangle imaging acting forces

The second problem is the alignment of the back leg. This problem cannot be directly solved only by equations. The experience of physiology and biomechanics is needed but there are some important arguments that the supporting, back leg has to be bent and the lower spine straight. Additional priorities of the stance are:

1. keeping balance
2. low effort of the muscles used for body actions
3. punch energy absorption

In order to keep balance it is better to keep the back straight. Center of gravity is exactly above the surface of the stance and the weight is distributed evenly on both feet. Any leaning on the body makes your center of gravity move towards the borders of the stance surface. It is close to loss of balance. It is also the reason of unnecessary back muscle tension because of undesirable torque acting on the body. Finally, body weight is located mostly on the front leg, but this leg does not create movements in this scenario.

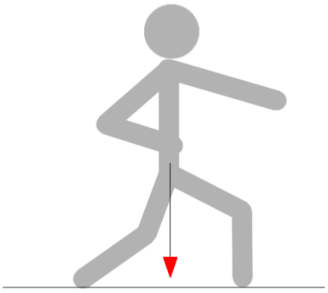

Fig. 4a
Free stance (zenkutsu dachi) with the center of gravity above the stance surface. The weight is distributed evenly on both feet

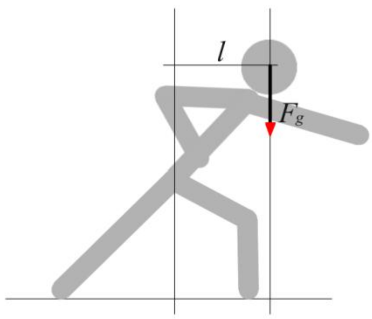

Fig. 4b
Classic stance (zenkutsu dachi) with the center of gravity above the stance surface but with the non zero torque requiring additional back muscle tension. The non-zero torque $M = l \times F_g$ is a result of leaning body

The third point mentioned above can be directly supported by the third Newton's law of dynamics. Every force that is used during a punch is connected with the force of reaction. Especially the response *R* of the floor to force *F* applied by the fighter. Such a response adds to the weight and the resultant force F_s acts on the spine. This is not the strength that spine can tolerate without health consequences.

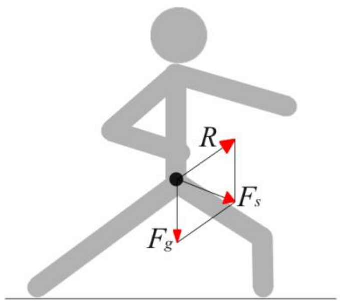

Fig. 5a
Forces acting on the lower spine when the classic stance is used. The F_s force can be a reason of damaging the spine

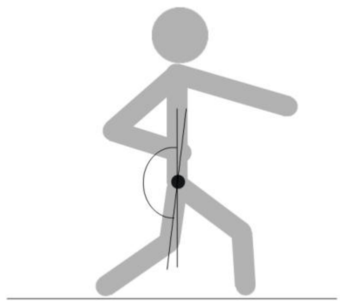

Fig. 5b
Zenkutsu dachi with maximum efficiency and safety. Note that the angle between the spine and the back leg is almost 180 degree. The force acting on the spine is equal almost zero. In order to ensure the lower back to be straight abdomen muscles should be slightly tensed and the tail bone tucked in.

Summary

The common version of zenkutsu dachi for kata and kumite is a natural consequence of some technical aspects of this stance. These aspects can be show as follows:

1. The lower back straight offers safety to the spine especially in the punch time. The bent leg becomes the engine of all moves.
2. Bent leg allows also the fighter to move rapidly and quickly and facilitate the whole back foot to be placed on the floor. This disables energy dissipation taking place due to heel moves after the punch
3. The lack of unnecessary muscle tension improves efficiency of the stance
4. The torque reduced by the straight back enables bigger mobility of the fighter