The Impact of the Specific Conditions of Sandstone Rock Climbing on Climber’s Performance

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Abstract: The aim of the research is to demonstrate the influence of the specific conditions in sandstone climbing on the performance of a climber. We have proved the higher rate of risk during sandstone climbing than during sport climbing. We have defined the typical display of gained personal climbing level. We have compiled a unified scale of difficulty for sport and sandstone climbing. The results of the research prove difference between performance of climbers in sandstone climbing and sports climbing. The extreme individual performance of climbers in sandstone climbing is according to the scale of difficulty lower than in sports climbing.

Key words: Mountaineering, Rock climbing, Performance, Sports Climbing, Sandstone Rocks, Rate of Risk

1 Introduction
Climbing is a sport field where everyone can realize their potential. One climbs to the summits in the easiest possible way and enjoys beauty of the surrounding countryside, while the other tries to climb the most difficult route. Climbing offers a wide range of disciplines that are extremely different from one another. For example there is bouldering on one hand and high altitude climbing on the highest peaks on the other hand.

In this paper we deal with the impact of specific conditions of sandstone rock climbing on the performance of climbers. We compare the performance of climbers on extreme sports climbing routes with their performance on the sandstone rocks. We perceive the extreme performance of climbers as the maximum of the difficulty rating that can be reached. Difference in the specific conditions is determined by the different nature of the sports climbing routes and sandstone rocks.

2 Problem Formulation
Sports routes are characterized by very good fixed protection equipped with bolts. Any fall of the climber is short and relatively safe into a solid fixed gear. Climbing on the sandstone follows the rules of sandstone climbing [1]. If there are fixed rings for belaying, their mutual distance is much longer than in sports routes. Additional protection can be based only by the climbers themselves and they are allowed to use solely slings. Any fall during sandstone rock climbing is often very long and dangerous, since the resistance of self-placed protection and belay devices does not have to be sufficient enough. Therefore the level of risk during sandstone climbing is much higher than during sports climbing. Sports climbing seems to be the least risky discipline according to safely fixed protection. The rate of risk in sandstone climbing is significantly higher. This statement is in accord with the works of several authors [3], [8], [9].

Many Czech climbers engage in both disciplines. They reach their own extreme performance given by the highest degree of difficulty they are able to climb. The difficulty of each climbing route is given in the climbing guides in the existing classification scales [10]. The most commonly used scales of difficulty in Europe are the UIAA scale and the French scale of difficulty for sports climbing and Saxon scale for sandstone climbing [9]. Majority of the routes worldwide are described in the climbing guides and there is also their rating. The classification of each new route is proposed and submitted for the committee’s approval. They confirm the classification or adjust it according to the reference of other climbers. This procedure has to precede the inclusion of each new route in the official climbing guides. Classification of climbing routes, or the scale of
difficulty, is a measure system for comparison of climbers’ performance [7]. An important standard for assessing the performance is the style of ascent. Abbreviation OS (on sight) means climbing the route at the first attempt. Climber has no information about the route in advance; he or she has to climb at the first attempt as a leader and without falling or hanging in the rope. OS is the most appreciated style of ascent when using a rope [10], [11].

2.1 Objective
To demonstrate the different level of extreme performance of rock climbers in dependence on the specific conditions.

2.2 Hypothesis
Extreme individual performance of climber is lower in sandstone climbing than in sports climbing due to different specific conditions.

2.3 Research question
Does the level of extreme climbing performance depend on the level of risk determined by different specific conditions?

2.4 Methods
Empirical, descriptive, causal, quantitative and qualitative research.

2.4.1 Research Methods
Quantitative analysis, content analysis of documents, scaling, questionnaire.

2.4.2 Participants
Basic set: The climbers engaged both in sports climbing and in sandstone climbing in traditional locations in Bohemia and Saxony.
Intentional selection criteria: Performance in sport routes and sandstone routes of at least the third degree of difficulty by OS style (on sight). The ratio of the frequency of sports climbing and climbing on the sandstone rocks is not regarded as significant.

2.4.3 Variables
Independent variable: specific conditions of sports climbing and sandstone climbing.
Dependent variable: Extreme individual climbing performance.

2.4.4 Data collection
Comparative content analysis of scales of difficulty used in climbing.
Controlled-structured interview, questionnaire sheet, control technology – questioning of 10% of respondents.

2.4.5 Data analysis
Quantitative descriptive statistics and correlations.

3 Problem Solution
In order to compare the performance of climbers, we had to create a unified scale for sports routes and sandstone climbing. We compared various classification scales available in the existing literature. We chose the UIAA scale as a base for conversion and further comparison. We added the level of an intermediate of 0.5. This level corresponds to the auxiliary values of “+” and “-“. For example, degrees VI+ and VII- have their numeric value of 6.5. We transferred French and Saxon rating system to the UIAA scale according to the comparative tables [2], [4], [5], [6], [11].
All the collected data were converted to the numeric values that fit statistical processing. The UIAA scale contents figures and signs of "+", which means harder, and ",", which means easier, with reference to the preceding figure. The French scale contains figures and letters a, b, c, combined even with the sign of "+". Saxon scale uses the Roman figures and letters from the level VII higher.

Table 1: Scale of difficulty – conversion table

<table>
<thead>
<tr>
<th>Value</th>
<th>UIAA</th>
<th>France</th>
<th>Saxon</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>III</td>
<td>3b</td>
<td>III</td>
</tr>
<tr>
<td>3,5</td>
<td>III+, IV-</td>
<td>3c</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>IV</td>
<td>4a</td>
<td>IV</td>
</tr>
<tr>
<td>4,5</td>
<td>IV+, V-</td>
<td>4b</td>
<td>V</td>
</tr>
<tr>
<td>5</td>
<td>V</td>
<td>4c</td>
<td>VI</td>
</tr>
<tr>
<td>5,5</td>
<td>V+, VI-</td>
<td>5a, 5b</td>
<td>VIIa</td>
</tr>
<tr>
<td>6</td>
<td>VI</td>
<td>5c</td>
<td>VIIb</td>
</tr>
<tr>
<td>6,5</td>
<td>VI+, VII-</td>
<td>6a, 6a+</td>
<td>VIIc, VIIa</td>
</tr>
<tr>
<td>7</td>
<td>VII</td>
<td>6b</td>
<td>VIIIb</td>
</tr>
<tr>
<td>7,5</td>
<td>VII+, VIII-</td>
<td>6b+, 6c, 6c+</td>
<td>VIIc, IXa</td>
</tr>
<tr>
<td>8</td>
<td>VIII</td>
<td>7a, 7a+</td>
<td>IXb</td>
</tr>
<tr>
<td>8,5</td>
<td>VIII+, IX-</td>
<td>7b, 7b+</td>
<td>IXc, Xa</td>
</tr>
<tr>
<td>9</td>
<td>IX</td>
<td>7c, 7c+</td>
<td>Xb</td>
</tr>
<tr>
<td>9,5</td>
<td>IX+, X-</td>
<td>8a, 8a+</td>
<td>Xc, Xla</td>
</tr>
<tr>
<td>10</td>
<td>X</td>
<td>8b</td>
<td>Xlb</td>
</tr>
</tbody>
</table>

All rating scales are ordinal; there is not the same distance between the consecutive levels. Conversion tables for comparing classification scales sometimes slightly vary in different sources. We worked with more sources, and created our own table that enables conversion of different systems of climbing classification into a unified numerical scale. This numerical scale should also eliminate the above-mentioned minor differences. Having used the method of structured questionnaire we received information from climbers who engage in both disciplines. The basic set consists of climbers who concern with sports climbing and climbing on the sandstone rocks, the key criterion was that the participants should be concerned with both mentioned disciplines. Absolute majority of the data were collected by a personal interview and several respondents filled in the questionnaire available on the website of the Czech Mountaineering Association. We excluded the climbers whose performance was lower than the third degree of difficulty in either discipline and which indicated a significant disparity between climbing on sports routes and on sandstone rocks. The number of respondents who met the selection criteria was 304. One of the criteria was the style of ascent - OS was required, because the number of attempts does not differ since the climbers must be successful at their first attempt. It is the most appreciated style of ascent.
The requirement was to climb at least 3 routes of the given difficulty. We eliminated unique performances reached on favourable conditions. We assume that if a climber’s performance is equal at least three times, it can be considered stable. The extreme individual performance of climbers on the sport routes is between $6^{th}$ and $7^{th}$ degree of difficulty. The extreme individual performance of climbers on sandstone usually ranges between $5^{th}$ and $6^{th}$ degree of difficulty. Noticeable is the extreme shift to higher levels of performance in sports routes. This shift corresponds to almost one full degree, precisely the value of 0.94.

Fig. 1: Comparison of extreme individual performance in climbing on sport routes and on sandstone rocks

The average of the extreme individual performance on sport routes is 6.72. It corresponds to 6+, 7 – of the UIAA scale or 6a, 6a+ of the French scale. The average of the extreme individual performance on sandstone rocks is 5.78. It corresponds to the degree VII of the Saxon scale. The average difference in climbing performance in the selected disciplines was 0.94, which is significant. Average values of the extreme individual performance of climbers are 6.5 for sports routes and 5.5 for sandstone rocks. Student's parametric t-test and Wilcoxon nonparametric test for dependent samples showed a significant difference between the extreme individual performance on sport routes and sandstone rocks (the level of probability $\alpha_{0.05}$. 253 climbers (83%) reported higher individual performance on sports routes, 16 climbers (5.3%) reported higher individual performance on sandstone rocks and 35 (11.5%) climbers had the same performance in both disciplines. To determine the relationship of 2 ordinal traits we chose ordinal Spearman coefficient. Correlation coefficient of extreme individual performance in sport climbing and sandstone rock climbing has the value of 0.81.

4 Conclusion
We determined the difference in performance of climbers on sports routes and sandstone rocks. Hypothesis, assuming that the individual extreme performance of climbers is lower in sandstone climbing than in sports climbing due to different specific conditions, has been verified. The extreme individual performance of climbers is higher on sport routes and is in accordance with the scale of difficulty higher than performance on the sandstone rocks.
References